THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 47. Thursday, December 22, 1932. No. 853.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of
THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.
Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3961 (5 lines).

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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Cylinder Liner Wear.—I.

A distinct service has been rendered by Engineer Rear-Admiral J. Hope Harrison in a recent Paper on the above subject, for he has collected together a number of the factors which influence the wear of cylinder liners, and which should be fully understood both by engineers and metallurgists. The question of wear is one of the most difficult which the metallurgist is called upon to face, simply because it is affected by so many things which lie completely outside his purview and over which he has no control whatever. As the author points out, although excessive wear has been alleged to be due to ash, improper lubrication, piston-ring pressure, broken or improperly-fitted rings, unsuitable material for rings and liners, incomplete combustion, piston tilt, atmospheric dust, sulphur from fuel, etc., no one—not even those who consider that they know why linings wear—has been successful in avoiding it. He also points out that the evidence of actual experience is not easily obtained, and that much of it is contradictory.

Perhaps the most interesting point in the Paper is the impression derived from a rapid survey that the actual material of the liner or the piston ring is a comparatively small part of the question, and one of the most important factors is lubrication. The oil is required to form a film on the liner walls and to seal the piston rings against gas. The experience of a number of users is quoted with respect to lubrication and piston-ring design.

The effect of dust in the atmosphere is not considered to be important in this country whatever may be the importance of it in bearings. The author deals with some of the materials of which liners have been made, including ordinary cast iron and alloyed cast iron, centrifugal iron, and heat-treated metal; in addition, there are carbon steel, alloy steels and nitrogen-hardened steel. He suggests that the present evidence is such that no one material has proved it is outstandingly better than the others with respect to wear, and indeed suggests that when records of many of the materials are closely examined, it is doubtful whether much progress has been made beyond the results obtainable from a good cast iron.

The remaining point dealt with relates to distortion, and it is suggested that there is no evidence that liners having a high tensile strength wear less than those of a low tensile strength. The important points to attend to are the maintenance of the original compression pressure in each cylinder, the maintenance of normal exhaust temperatures, and the periodical cleaning of the liner from scale on the water-jacket side. Lubrication should be good, and incomplete combustion should be avoided.

The discussion on the Paper was particularly interesting, and we hope to come back to this at a later date.

Casting Displaced by Welding.

Up to now, we have always taken up a very conciliatory attitude towards weldings, but when a responsible organ such as "The Times" Trade and Engineering Supplement allows a correspondent to indulge in such statements as "It can be safely stated that 90 per cent. of the parts made of cast iron can be made of standard steel shapes arc-welded into a homogeneous whole," it is obvious that conciliation is premature and that war should be carried into the enemies' camp. Weldings may be defined as an exotic post-war development involving the assembling of steel plates and sections—sometimes of standard dimensions—by means of uncontrolled meroscopic castings. These weldings spring after machining; are liable to excessive corrosion; are subject to being bent, which is usually worse than a break; lack rigidity; are dependent on the skill of men usually trained in a hurry; and incapable of conforming to proper acceptance tests. They constitute a fashion which is on the wane, because of high cost of manufacture (ask your buyer), poor life (electrical junction boxes), and failure in practice (road rollers). Welding is a one-man job and difficult to convert into team work, and therefore can never compete against a highly-mechanised foundry. Their bull point—the elimination of patterns, is untenable when one thinks of radiators, motor-car castings, pipe castings (where no patterns at all are used), of the small junction boxes such as are turned out by the Midland Electric Company, or the small electrical castings made by Ferranti and others. "The Times" correspondent asserts: "Another advantage of welding is that less space is required for manufacturing when steel is used in the place of cast iron. Less time also is required for fabricating from steel than for the manufacture of castings." Both these statements are unsupported, and obviously assume (1) that the welder has the correct sections in stock; (2) that no pattern is available to the founder; and (3) that it is a small order job in point of numbers required. For production per unit floor space, we defy any welding plant to show a figure to equal that attained by Midland Electric Manufacturing Company and other quantity production foundries based on either weight or volume. A final quotation—"A welded steel bedplate is less liable to damage than a cast-iron bedplate"—is typical of the assertions made in this article. Here the author means "breakage," but bedplates are damaged, and seriously damaged, by slight bends and warps, unknown in cast iron. We will not only again assume a conciliatory attitude, but one of real co-operation as and when we find the welding outlook towards castings getting into sane perspective.

O

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Malleable Reception Tests.

To the Editor of The Foundry Trade Journal.

Sir,—In your issue of the 1st inst. you published a letter from John V. Murray relating to the discussion on the report of the Malleable Iron Sub-Committee Paper at Newcastle.

In this letter Mr. Murray states that it is quite possible to obtain a yield-point as low as 40 tons and as high as 95 tons per sq. in. in well-annealed malleable castings.

This is a surprising statement, as it is well known that malleable-iron castings, even when heat-treated, cannot give such high figures as Mr. Murray quotes.

This is evidently a typist's error, and should be amended so that such a statement should not mislead the general reader.—Yours, etc.,

J. W. Gardom, Convener.
The Institute of British Foundrymen.
Technical Committee.

Soda Ash.

To the Editor of The Foundry Trade Journal.

Sir,—Doubtless, with many others of your readers who use soda ash regularly, the writer looked forward to finding something of practical service in Mr. Evans Paper—in the Journal of December 1—as it is often difficult, sometimes impossible, to get a real sample of the metal to be treated, and as no one wishes to use up soda when the temperature is not suitable or a greater quantity than is really beneficial, we looked for some guidance on such points as the best methods of applying it, on the minimum temperature, at which its full effect could be obtained, and what effect varying proportions would have in ridding metal of sulphur. Table 1 gives some absolutely incredible data. It seems to show the effect on the sulphur and manganese contents of metal before and after treatment. If the results are to be taken as printed, then "Tropenas" steelmakers would be well advised to look closely into their already large metal losses.

In four out of five cases cited the manganese has increased in quantity in the treated metal. Now, as the manganese reported in an analysis includes all forms in which it may exist (carbide, sulphide or simply alloyed)—if the metal after treatment by soda ash contained *more* manganese (as reported), this could only come from its concentration into a smaller weight of metal, such smaller weight, indicating serious loss, being the result of the treatment. (Cr and Mo are said also to gain in quantity.)

Considering that (as was settled experimentally by Sir Lowthian Bell some 60 years ago) hot CO_2 oxidises metallic iron very rapidly, it seems hopeless to expect any good result from treating metal by passing such gas through it to degasify it. I fancy the author would hardly recommend the use of soda ash on a ladle of steel to clean and degasify it, although it is claimed not to affect the ordinary steel constituents and to increase the manganese, chromium and molybdenum.

The test-bars cast from the same material, dirty-pipe scrap, show a wonderful difference in structure. The metal being fused without any flux and with no carbon additions, would, naturally, be very susceptible to *any* fluid-slag additions. The Fe_2O_3 of the dirty scrap is very infusible and does not combine readily with sand. In ordinary cupola melting, *at its worst*, this peroxide is reduced (by the CO of the cupola gases and the hot coke where it touches) forming the lower oxide, which combines readily with silica, forming an all-too-fusible slag for the average cupola lining to withstand. Cupola metal from the *dirtiest scrap* could never be so bad as the untreated bar shown in Fig. 13, and with the extra quantity of slag—due to the dirt—may indeed be much cleaner than the average melt. This article indicates very clearly that it is of great advantage to have a thin fluid slag in the cupola. Whether modern practice would be improved by working with a tougher slag, which would not be so severe on the cupola lining, and treating all the metal in the receiver (or ladle) with some material forming a thin slag of low specific gravity, or, alternatively, by using suitable fluxes in the cupola itself, to form a thin and very liquid slag, is an open question.

One thing might be tried. As there is a large amount of unchanged soda left in the slag, resulting from treating the metal, such slag ordinarily thrown away, might be put through the cupola to improve the slag and to remove some sulphur.

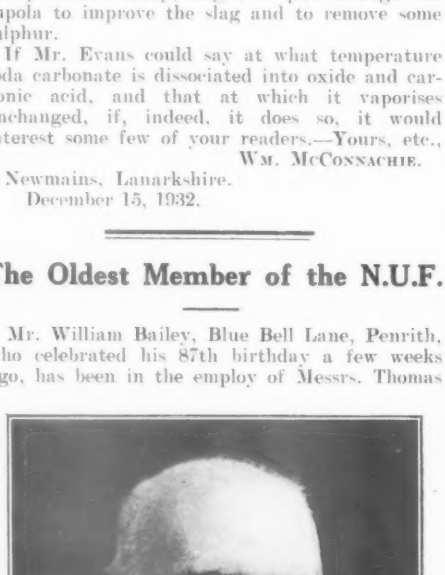
If Mr. Evans could say at what temperature soda carbonate is dissociated into oxide and carbonic acid, and that at which it vaporises unchanged, if, indeed, it does so, it would interest some few of your readers.—Yours, etc.,

Wm. McConnachie.

Newmains, Lanarkshire.
December 15, 1932.

The Oldest Member of the N.U.F.

Mr. William Bailey, Blue Bell Lane, Penrith, who celebrated his 87th birthday a few weeks ago, has been in the employ of Messrs. Thomas



Mr. William Bailey.

Althams & Son, ironfounders, of Penrith, for 73 years, having been apprenticed when he was 14. He is still working, or rather, as he himself calls it, "assisting the other workmen," although he is officially pensioned off. Nearly every day he dons his old blue jacket, and sets off to his job, just as blithely as he did nearly three-quarters of a century ago.

"Old Bill," as he is known to everyone, is a native of Penrith. He still potters about at the works, doing a little light work, and means to continue as long as ever possible.

Mr. Bailey, who appreciates a glass of beer and a cigarette, is the oldest member of the National Union of Foundry Workers. He believes in hard work, and has, as he says, had plenty of it all his long life. He is still wonderfully hale and hearty, and the only thing that worries him is his deafness.

Random Shots.

This toy-soldier business is becoming a problem, worthy to rank with the war-debts affair. Serious-minded women (the sort whom the B.B.C. hire to give improving talks on "International Hygiene" and "How the Mind of the Bee Works") long ago pointed out the insidious effect of lead soldiers on the impressionable minds of children, proving conclusively that the antics of Tamberlaine, Alexander, Hannibal and Napoleon were entirely due to the warlike atmosphere of their childhood, engendered by the Christmas gifts of foolish and doting aunts. At an inter-University debate, held in Birmingham recently, when the matter was discussed, a point was raised which "Marksman" thought was of considerable interest to the foundry industry. A practical delegate from Sheffield, deviating from the question as to whether children should be given toy soldiers or nice, woollen gloves, suggested that the soldiers should be made of stainless steel instead of lead. The child, of course, would miss the satisfaction of sucking off the red paint, but all the same, from the point of view of the stainless-steel trade, there are possibilities in the idea.

* * *

A walk down Oxford Street or Holborn to-day will show you father trailing around from large store to large store, laden to the chin and fed up to the back-teeth. You will see mother telling her offspring exactly why they should prefer warm underclothing to clockwork trains. You will see the children prodding the commissionaires to see if they are real, and you will hear, if the children's parents are not near, what the commissionaires say. Lurking in dim corners you may observe comic artists taking notes for next year's annuals. If you are wise, however, you will avoid the Toy Fairs, where for an exorbitant sum you are shown an unlikely Santa Claus (a sandwichman in civil life) leaning against a thirty-guinea stuffed rhinoceros (at the sight of the pachyderm the children scream, and you have to hold one, while its mother attends to those who have been seized by hysteria). In fact, all around you can be seen unscrupulous shopkeepers selling the most ridiculous and unwanted impedimenta, designed apparently for elderly aunts to give to unfortunate nephews. All around you there is buying and selling, and you will ponder: where amidst all this Christmas trade does the foundryman come in? No elderly aunt ever sends iron castings to her nephews, although they would be more useful than vermilion neckties. No, unless there is a revival of the use of iron platters in place of Spode china there seems no hope for the foundry trade in this festive season.

* * *

"Marksman" last week quoted an excellent story from a witty speech by Mr. Kain at the London Branch dinner of the Institute. Unfortunately, however, he has been told that he missed the point, although the story as published seemed funny enough. However, if any reader did not see the joke, the correct version will be sent him in a plain van, price £3 19s. 11½d. The fact is that a really good dinner, such as that of the London Branch, must be expected to blunt the point of any joke, both in the hearing and telling thereof.

* * *

Another joke which can be easily mistold is that of the excitable man at the football match, who said: "I b-bet you a pair of drawers it's a glove."

* * *

A flag-seller approached an extremely fatuous young man. "Will you please help the Working Girls' Home?" she asked sweetly. "I say, yes, rathah," said the man, "but, where are they, don't you know, what?"

Marksman.

The Effect of Size of Specimen on the Strength and Elastic Properties of Cast Iron.

Mr. A. H. Dierker has published in the Engineering Experiment Station Bulletin No. 72 (Ohio State University Studies, Engineering Series), details of a research he has made on the above subject. In conducting the research he took the following desiderata into consideration.

The present standard-test specimen for cast iron is the so-called arbitration bar. This is a round bar 1.20 in. in dia. by 21 in. long, poured vertically in dry sand. The bar is tested by placing it on supports 18 in. apart and applying a load at the centre. The advantages of this type of bar have been well stated by Moldenke:—"The round section eliminates errors from four hard corners; the vertical position in the mould eliminates differences in strength found in flat-poured castings when tested cope side up or cope side down. Pouring from the top means giving every inch of the vertical casting molten metal of the same temperature and is the only way of getting this casting as sound as such a casting can be made, the casting practically feeding itself as it is poured. Dry sand for the mould means the elimination of a hardening (strengthening) influence from the dampness of the ordinary green sand."

Further advantages of this type of test-bar, advantages which undoubtedly have kept it in the favour of the average foundryman for many years, are that it is easy to make, requires no expensive machining, and can be tested on a simple inexpensive machine. For those who prefer the results of their test expressed in tensile strength, a tensile bar has been adopted as standard. It is specified that this tensile bar is to be machined from a broken half of the arbitration bar.

In considering means for testing the physical properties of a series of cast irons to be made at the Engineering Experiment Station it was felt that the use of the arbitration bar would be of questionable value. This bar is made in a manner entirely different from ordinary foundry practice and no correlation has ever been worked out between the properties of this test-bar and the property of the castings poured from the same metal. The transverse test on the arbitration bar is probably suitable for indicating variations in the uniformity of a given composition of metal. Its value, however, for indicating the suitability and value of a given composition for casting purposes is severely limited. Since the standard tensile bar is to be machined from the transverse bar the same objections would hold to its use for investigational purposes.

It is usually conceded that the best method for determining the value of a given iron for a particular casting is to test the casting as a whole. The properties of grey cast iron vary widely, however, in sections of different size; hence the properties determined in one casting may not hold for another similar casting of either lighter or heavier section. It would appear logical then, in investigational work, to cast the metal into a series of castings of varying size, these to be of a simple shape so as to be readily and easily tested and to be moulded and poured by usual foundry methods.

The Engineering Experiment Station had on hand patterns for a series of simple castings of similar design but varying in size. These had been designed with another purpose in view, but a slight modification made them suitable for the present purpose. In testing, the bars are simply gripped between the flat grips of the test machine and pulled in tension. Although there is no assurance of true axial loading it is questionable if any serious bending stresses are set up provided the gripping surfaces of the bar are parallel and the testing machine is in good condition. Tests of a number of bars cast from various melts indicated that the idea had considerable merit. The decision arrived at, therefore, was to make as complete a test as facilities would permit of one melt of cast iron considering both elastic properties and ultimate strength.

The type of iron chosen for this melt was one which was considered to be suitable for medium- and heavy-section castings. The composition aimed at was T.C., 3.20; Si, 1.75; Mn, 0.60; S under 0.05, and P, 0.12 per cent. The charge consisted of 334 lbs. of scrap iron from previous laboratory melts, 50 lbs. of charcoal pig-iron and 1½ lbs. of ferro-silicon. The metal was melted in a single-phase, direct-arc, electric furnace.

Conclusions.

The results of the tests reported show, according to the author, conclusively that, moulding conditions being equal, the deformation per unit stress in ordinary cast iron varies according to the size of the section in which the iron is poured. The difficulty of judging this variation from the results of a single-test specimen is apparent. Moreover, in the absence of more conclusive data than have been published, the author questions the advisability of basing judgment on the results of tests of small specimens extracted from various parts of the casting. The physical properties of a given section in a structure are not necessarily a summation of the properties of the various components forming the member. It would seem desirable, in determining the physical properties of cast iron in sections of varying size to test, whenever possible, each section as a whole.

Incidentally the data given indicate that reasonably good mechanical properties can be secured in grey cast iron without the necessity of resorting to unusual compositions or excessively high temperatures.

Foundry Practice in Belfast.

At the November meeting of the Belfast Association of Engineers, MR. PHILIP B. JAMESON, managing director of Brown Square Iron & Brass Foundry, Limited, 49, Turin Street, Grosvenor Road, Belfast, read a Paper on "Cast Iron Practice in a General Jobbing Foundry."

After dealing with the early history of the industry, Mr. Brown stated that the sands used locally were "Red," "Rock," "Sharp" and "Sea," and that Belfast was fortunate in the possession of sands equal to those found in any other district. The "Red," which constituted the bulk of the sand used, was naturally bonded.

Pipe Moulding.

The author dealt at length with the making of pipe castings, and drew attention to the following points:—(1) A pipe mould must be rammed according to its diameter to withstand the pressure of the metal during casting; (2) facing sand must be used suitable to the thickness of metal in the pipe; (3) weaker facing sand, with a small percentage or no coal dust should be used on the top surface of the mould; (4) in ramming, the rammer must never be allowed to approach too closely to the pattern; (5) the careful placing and securing of chaplets in suitable positions to prevent the core rising or bending when the mould is being filled with molten metal; (6) before using chaplets, they should be examined to ascertain that they are properly tinned and free from rust, as rust on chaplets is sure to cause blow-holes where it comes in contact with molten metal; (7) the core should be dry before placing in the mould; (8) the core must be the same diameter as the coreprints, otherwise difficulty will be experienced in centring; (9) a hot core should never be placed in a green-sand mould, as the condensed steam will form in beads of water on the top surface and cause blow-holes in the casting; and (10) when pouring a pipe mould, the molten metal should be as fluid as possible, especially for pipes of light section, and the pouring basin made high to give the necessary pressure.

When making a straight-pipe core, a core barrel of suitable length and diameter, with perforations to allow of the free escape of gas, must be provided. This is wound with straw, hay or wood-wool rope, allowing for at least ½-in. coating of loam. The core is formed with a strickle board placed on stands, first rough coated, then finished with thinner loam. When dry and tested for size, it is finished with blackwash to ensure its easy removal from the casting. Blackwash is graphite with a little clay added mixed in water.

Large fillets are often called for around pipe flanges, but this is not good practice, as the increased thickness of the casting at this point causes porosity and gives a leaky pipe. Small brackets at the back of the flanges overcome this difficulty and, incidentally, produce a much stronger job. The designer should always aim at having a casting uniform in thickness, with all corners round where possible.

Camber.

Camber, necessary in patterns, has always been a problem, as there is no fixed rule for guidance. Where there are one or two castings only, to be made of a pattern, the jobbing foundry cannot afford to make trials, and judgment from experience, with due precaution as to gating, must be exercised so that the casting will keep a uniform temperature throughout when cooling. This is more difficult with castings having varying thickness. Extra machining should always be allowed for on long castings requiring a finished level surface.

Gating and Running.

The gating of a casting is most important. Many otherwise well-prepared moulds have been lost by improper gating. Some years ago a large foundry, which had been having trouble with a high percentage of bad castings, consulted the author on the matter, and he was taken through the machine shops to see the various castings which had been machined, and rejected. The works manager stated his firm would not have any necessity to buy scrap for the following twelve months. On investigation, it was found that 95 per cent. of the trouble was caused by wrong methods of gating and pouring. The patterns had been mounted for machine and plate moulding with a view to quantity without due regard to proper gating. Plate moulders when casting had followed a system of pouring the metal slowly to prevent straining the mould. This was done to avoid the putting on of weights or clamping.

When pouring a mould the runner basin should be filled as quickly as possible and kept full until the mould is completely filled with metal. The more head pressure in pouring the greater will be the force exerted on the molten metal entering the mould. If not controlled by proper gating this is liable to cut the mould where the flow of metal strikes, causing scabs, the sand displaced mixing through the metal, resulting in a defective casting. Down gates should not be larger than the total area of the sprays. Molten metal should enter the mould with a smooth, even flow without agitation, and to minimise warping, gates should be arranged to distribute the metal quickly to all parts of the mould so that contraction may take place uniformly throughout.

In a jobbing foundry greater skill is required than in a foundry doing specialised or repetition work. If a sufficient quantity is required of any casting, everything can be made as foolproof as possible. The patterns with gates can be mounted on plates for machine or plate moulding and special boxes made to suit, thus reducing the skill required for moulding. If a suitable facing sand and mixture of metal is

(*Concluded on page* 389.)

XUM

The Practical Application of Soda Ash.

VIEWS OF PROMINENT FOUNDRY EXPERTS.

Mr. N. L. Evans' Paper, which was published in our issue of December 1, gave rise to one of the most important discussions ever held under the auspices of the Institute of British Foundrymen. It was opened by MR. J. G. PEARCE (director, B.C.I.R.A.) who said everybody was very greatly indebted to Mr. Evans and his colleagues for the admirable work they had done on desulphurising by soda ash, because, without exception, every section of the industry—blast-furnacemen, refined-iron makers, chilled iron, grey-iron and malleable-iron makers and steel-castings makers—were interested. Why, he asked, is desulphurising important at a time when sulphur is nothing like the bogey it was? The answer lay in the extent to which the industry to-day was dominated by scrap. Once melted in the foundry, all pig-iron sooner or later returned as scrap. In the form of runners, risers and waster castings it returned to the furnace at short intervals. As good castings it might only return after years of service, but sooner or later it was bound to do so, and at each re-melting the sulphur rose from 0.03 to 0.05 per cent. There was thus a steady rise in the sulphur content of cast iron, and this had probably been trebled in the last thirty years.

Why was sulphur less feared than it was? The reason was that we now have a proper understanding of many troubles for which sulphur at one time was a convenient scapegoat. Furthermore, founders had learned better how to balance it with manganese. That a sulphur-manganese relationship existed had long been known, but its precise nature was explained by the work of Norbury in the laboratories of the British Cast Iron Research Association. This work explained the paradox why in some cases manganese additions hardened and whitened the iron and in other cases they softened and graphitised it. To neutralise a given part of sulphur, manganese must be present to the extent of 1.7 times the sulphur, plus an additional 0.3 per cent. A smaller quantity of manganese than this hardened the metal by leaving some sulphur free to exercise its drastic hardening action by dissolving in the iron carbide as ferrous sulphide. A greater quantity tended to harden the metal by leaving excess manganese free to form manganese carbide, which crystallised with, and was more stable than, iron carbide. The affinity between manganese and sulphur was offset by the affinity between manganese and carbon and between iron and sulphur. One of the problems of the founder was to maintain this balance in the face of increasing sulphur due to pick-up from cupola coke and diminishing manganese through oxidation in the cupola. It was nevertheless interesting to find that soda ash was equally good at breaking up ferrous sulphide as manganese sulphide. If one could neutralise sulphur satisfactorily by manganese, why was its reduction so important? During the war a vast amount of metal was melted from sub-normal raw materials and a considerable increase in sulphur content took place. The availability since that time of war scrap and the economic necessity for using increasing proportions of scrap had resulted in greatly increased sulphur content.

Pig-Iron Desulphurisation.

Why was desulphurisation not practicable at blast furnaces since this would appear to be the ideal place at which to do it? As Mr. Evans had pointed out, British pig-iron did not contain a serious quantity of sulphur. The hematites in fact were so low in sulphur that many castings such as ingot moulds could be produced with sulphur within the limits of a usual steel specification. If the foundry industry were in a position to melt nothing but pig-iron, the sulphur problem would not arise. An exception to this might be made in the case of low-silicon pig-iron used for white-heart malleable iron. In normally-operated blast furnaces the usual medium-silicon grey pig-iron produced at a relatively high temperature was lower in sulphur than low-silicon pig, and malleable pig carrying, say, 0.6 per cent. of silicon might have 0.1 per cent. to 0.2 per cent. of sulphur. Makers of refined iron were also in an excellent position to desulphurise and the necessity was, of course, greater than with blast furnaces. The opportunity was good because they handled metal in sufficient quantities to make ladle additions practicable, and pouring temperature was not so important to them as to the founder. It was understood that refined iron-makers were availing themselves of the opportunity to desulphurise which soda ash offered.

B.C.I.R.A. Tests Confirm.

So far as grey iron was concerned, there was no possible doubt whatever of the reduction of sulphur by means of soda ash. The B.C.I.R.A. carried out tests in, and subsequent to, 1925 and it could be said from these tests and experience that Mr. Evans' conclusions were correct and correctly stated. Moreover, they had been confirmed by dozens of investigators from different countries. The main difficulty in the foundry was a purely practical one, namely, the time required for the reaction. As Mr. Evans had pointed out desulphurisation was most easily accomplished in large castings where the ladle could be held. For small castings the metal became too cold for pouring. This was particularly the case in malleable iron where the sulphur trouble was most acute, where the castings were small, runners large, and the proportion of scrap going back to the furnace consequently great. Although manganese sulphide was the most neutral and suitable form in which sulphur could be present in cast iron, it was nothing more than an inclusion and was preferably excluded. Its removal materially improved the elongation of malleable. The alternative of pigging desulphurised metals and remelting it was open to the objection of the cost of remelting and the sulphur pick-up on the remelt might be an appreciable fraction of the removal on the first melt.

Soda-Ash Blocks.

The use of soda-ash blocks in the cupola was an ingenious suggestion to overcome the difficulty of dealing with small ladles, but there was very little experience of this yet and the results of the use of blocks would be watched with interest. Since most cupolas had a siliceous lining, the possibility of action between the soda ash and the lining was present. It also did not appear how the degasifying action of soda ash in the ladle could be made effective.

In considering the figures given in the Paper, it should be borne in mind that any manganese figure obtained by the ordinary process of chemical analysis in a routine testing laboratory was subject to an analytical tolerance of $\pm$ 0.02 per cent. Thus, a manganese content of 0.40 per cent. meant that the manganese figure was anything between 0.38 per cent. and 0.42 per cent. Thus the change in manganese after desulphurisation was really very slight, although it was in the right direction. Similarly, sulphur figures were subject to a tolerance of $\pm$ 0.003 per cent., so that 0.1 per cent. of sulphur recorded by analysis meant anything between 0.097 per cent. and 0.103 per cent.

Limestone Additions.

What other steps could founders take to meet the sulphur trouble? The Association had, of course, always urged its members to minimise this as much as possible by all the usual methods available, particularly by the use of a generous limestone addition to the cupola. Maximum desulphurisation was effected and the greatest sulphur content was found in the slag when it carried about 30 to 35 per cent. of lime. This sulphur, of course, was derived from the coke. The more fluid the slag, the more desulphurising it was. The diminished coke consumption obtained with the balanced-blast cupola also reduced the sulphur pick-up.

Sulphur in Coke.

Are we ever likely to obtain a coke which would not give a sulphur pick-up? This raised the important question of the form in which sulphur was present in coke, on which a good deal of research was required. Sometimes a low-sulphur coke would give a greater pick-up than a higher-sulphur coke. Sulphur probably existed in fuel in at least two forms, organically and inorganically (as pyrites). It was important to find out how the total sulphur present was distributed in each of these two forms and how much of each was present in the ash, the fixed carbon and the volatile matter. We did not, of course, know whether sulphur entering the iron was derived exclusively from one of these two forms.

Has the soda-ash process any beneficial effect apart from desulphurisation? This raised the important question of gases in metals, which again had been blamed for many foundry difficulties, largely on account of the difficulty of determining their presence and quantity and the uncertainty of their effects. Tests carried out by the Association in passing hydrogen, nitrogen, mixtures of hydrogen and nitrogen, carbon dioxide, through molten cast iron, had shown very little effect on the resulting properties, but such effect as was obtained was favourable due to the scavenging effect causing inclusions to rise to the surface of the metal. Cases existed in which founders added soda to the metal and did not allow the reaction to proceed to completion—a fact, of course, of which everybody was perfectly aware. The main advantage of this procedure would appear to lie in the passage of carbon dioxide through the metal and the agitation arising therefrom freeing the metal from suspended impurities and inclusions. It was interesting to relate this to other work proceeding on the degasification of molten non-ferrous metals. The reference in the Paper to the possibility of soda ash acting as a modifier was by no means fantastic, and experience with cast iron suggested that modification might consist in the removal of particles from the melt, resulting in a supercooled structure. Owing to the ease of nucleation, supercooling was difficult to obtain in cast iron, and the soda ash might be helpful in this connection.

Finally, Mr. Pearce said that whilst the author's remarks with respect to economy arising from the increased use of scrap were quite correct as far as individual works were concerned, from the national point of view the more general use of scrap would undoubtedly result in price adjustments which would tend to offset the advantage temporarily gained.

MAJOR FREETH said that he was speaking somewhat in the capacity of a Dr. Jekyll and Mr. Hyde, inasmuch as he was a Vice-President of the British Cast Iron Research Association and also an official of Imperial Chemical Industries. In his capacity as Vice-President he wished to congratulate the Chairman and Directors of I.C.I. (Alkali), Limited, upon their foresight in purchasing an induction furnace which was more or less a key to the work, and also upon the very high scientific level upon which the work had been conducted. It was a level of which no scientific society need be ashamed. The Paper itself was down to brass tacks, but the speaker wished to emphasise particularly the scientific background. In his other capacity as an official of I.C.I., Major Freeth emphasised

the point that inquiries from possible users of soda ash would be welcome and every possible assistance would be afforded to them.

High Sulphur Removal.

MR. E. MILLINGTON said that, although everybody was familiar with the sulphur problem and the efforts that had been made to overcome it, this was the first time within his knowledge that it had been definitely shown how sulphur could be removed efficiently and successfully, and, what was more important, with certainty, and within well-defined limits which were not small limits. The use of soda ash had been brought to his notice really by the British Cast Iron Research Association, and as the result of discussions with Mr. Pearce he himself had put experiments in hand with the open-hearth steel-melting furnace, not on steel, but on cast iron. He had also experimented with the cupola, and in every case the sulphur removal had been quite definite. A figure as high as 64½ per cent. had been reached. In that case scrap locomotive cylinder metal was charged into a 50-ton furnace and melted down. When the alloys of manganese, silicon, etc., had been added, a sample was taken in the ordinary way and analysed, after which the metal was tapped into the ladle and desulphurised with soda ash and again analysed. It was then found that the original sulphur of 0.138 per cent. had been reduced to 0.049 per cent., a reduction of 64½ per cent. The process was then tried out in the cupola, and a figure of 63 per cent. was obtained. Other tests showed a figure of removal of sulphur as low as 23 per cent., but in that case the results were probably due to inexperience, or there were other factors which contributed to that low percentage sulphur removal. He did not attribute the result to the process. He had also carried out tests on the mechanical properties of the treated material, and had found that the claims made for a tendency towards an increase in strength had been confirmed. As the result of these experiments he had no doubt whatever as to the beneficial effects of desulphurisation, where necessary, by means of soda ash.

Degasification.

As the result of the work done by Dr. Norbury on the atomic proportions of manganese to sulphur, he had carried out a great deal of experimental work with very large proportions of scrap in his foundry, and the theory referred to had worked out very successfully. In this way there were two very valuable agents to deal with the bogie of sulphur. He had not yet made any investigations on the fineness of pearlite and the degasifying effect, but he presumed that the examples shown by the author were the results of practical work. It was known, of course, that there were different grades of fineness of pearlite in the same specimen, but he would like to know that the examples given by the author represented a wide field of work, and that they could be relied upon, because the results had a very profound influence on the mechanical properties as well as on the soundness of the castings. Similar remarks applied to the degasifying effect, because if it had to be assumed that all irons were detrimentally affected by gas, as suggested in the Paper, it would mean that sound castings were never obtained, whereas, of course, sound castings were obtained. The point to be considered was how far gas affected the metal generally, as from the economic point of view soda ash could not be regarded as essential in every case.

High Sulphur Cylinders.

On the general question of the presence of sulphur, Mr. Millington said it was often stated that, if a certain amount of sulphur was exceeded, it was impossible to make a good casting, but, as a matter of fact, there were dozens of locomotive cylinders in use with a sulphur content of 0.14 per cent., and although it might sound a little odd, he was a great believer in a certain amount of sulphur being present, for the very reason that it had a stabilising effect on the carbide and resulted in a harder and a much better wearing material. He did not think any question of legislating for the machine shop should enter into this. He believed the right policy was to legislate for resistance to wear and let the machine shop see that they procured machines to deal with the material. A good deal had been said as to what the machine shop thought about the foundryman, but perhaps the machine shop ought to know what the foundryman thought of the machine shop in this respect! The point to be considered was how far the sulphur should be reduced without affecting the resistance to wear, and that brought in another point, viz., was it essential to desulphurise all the iron, or was it possible to dilute it by desulphurisation? He had evidence to show how the sulphur pick-up occurred and in what proportions. The figures were very interesting, and it appeared that the higher the sulphur content in the original material, the lower the pick-up on re-melting, and, although the sulphur increased slightly, as Mr. Pearce had said, experience so far showed that, if the manganese was balanced, it was possible to counteract that increase of sulphur and still use a large percentage of scrap without recourse to sodium carbonate to get good castings. Therefore, there was an economic aspect as to the extent to which desulphurisation should be adopted. That was an important point upon which he would like more information. Another important matter was that it had been said the metal was more liquid after desulphurisation with soda ash. Whilst agreeing with this, his experience had been that after allowing the reaction to take place, although the metal appeared more liquid, its range of liquidity seemed to be shortened. This might be overcome with further experience and perhaps higher initial temperatures of melting which would permit of greater elasticity of flow and permit of desulphurised iron being used, whereas this would not be possible with lower temperatures.

Application to Steel.

MR. J. DESCHAMPS asked if the author could say whether the soda-ash process would be applicable to steel. Personally he did not think it would, owing to the very high temperature of molten steel, but he would like some confirmation of that view. In other words, would the temperature of 1,560 deg. C. volatilise most of the sodium before it had a chance of being effective? The author had stated that the desulphurising process was exo-thermic, but that seemed difficult to understand. The decomposition of carbonate was an endo-thermic reaction and not an exo-thermic reaction. Was it possible that the formation of sodium sulphide at the expense of iron sulphide was sufficiently exothermic to upset the loss of B.T.U. owing to the decomposition of the carbonate? He had had experience of the process for six years and his firm had, since 1926, dealt with 30,000 to 40,000 tons of metal, and the conclusion he had arrived at was that there is a loss of temperature which cannot be accounted for only by radiation losses. He also believed that it was associated with the endo-thermic nature of the reaction.

A Question of Temperature.

Some interesting remarks had been made in the Paper about the slight increase of manganese, but when reference was made to the silicon loss being 0.1 of one per cent., that was contrary to his own experience. He had found the loss of silicon was in the neighbourhood of 15 or 20 per cent., and that was one of the drawbacks of the process. His experience also was that the best effects were obtained with soda ash if it was introduced when the metal was at a very high temperature. In other words, with the same amount of soda ash used, say 1 per cent., there might be a removal of sulphur to the extent of 45 or 50 per cent. at 1,400 deg. C., but this would fall to about 20 per cent. if the temperature was 1,300 deg. C.

The most important function of treatment by soda ash was the removal of non-metallic inclusions, and Mr. Evans was probably correct when he said that it was due mostly to the evolution of CO_2 through the metal. Was it not possible, however, that in addition to the physical action of the bubbles of CO_2 rising up through the metal and carrying the non-metallic inclusions with them, there was a combination of the sodium elements with single silicates, causing the formation of multiple silicates which rose more readily in the slag? That was a point he had never been able to settle in his own mind.

Ladle Linings.

Then there was the question of the lining of the vessels or ladle in which desulphurisation took place. His experience was that a better desulphurisation was obtained if, instead of the lining being of firebrick, it was a neutral refractory containing the correct proportion of alumina to silica. The use of ganister resulted in a poorer desulphurisation than did the employment of a neutral lining. A basic lining should not be used because of the acidity of cupola slag, which interfered with the sodium carbonate. When he first used the process, the linings of the ladle did not last for more than one or two days, but since a neutral lining had been used which was neither basic nor acid, as many as from 280 to 300 heats were obtained without requiring relining of the ladle.

Adding the Soda Ash.

Finally, there was the question of the best method to add the soda ash. His experience had been that if the soda ash was added to the ladle when it was half full or was put into the stream of molten metal coming from the cupola, there was a great tendency for it to float to the surface of the metal. It would then desulphurise the top layer of metal and prevent the full beneficial effect of the evolution of CO_2. He had come to the conclusion that the best way to add the soda ash was to have a very hot ladle and deposit the soda ash at the bottom so that there was a partial caking which retained the carbonaté at the bottom of the ladle for several seconds, thereby compelling the evolved CO_2 to traverse the whole bath of metal and carry with it the non-metallic inclusions. Care must be taken, however, to see that the ladle was not too hot and that the soda ash was not deposited too long before desulphurisation was proceeded with. Could the author say what was the composition of the slag so formed? It was not sulphide of sodium; it could not be in the presence of oxides and silicates. Was it not a sulpho-silicate of sodium? Further, had the author any experience of the amount of sulphur combined with slag? In his own works and in many other works he had analysed the slag and found it contained 4 or 5 per cent. of sulphur. When the process was first adopted by his firm in 1926 he had been told that more than two million tons of cupola metal was being treated in America per annum. No doubt this figure would be larger at the present time. The process had also been taken up in this country more recently, and if the author had any figures relating to the total quantity of metal so treated here it would be extremely interesting.

MR. A. C. HETHERINGTON, representing the Department of Scientific and Industrial Research, expressed the regret of Sir Frank Smith, Secretary of the Department, for his inability to be present at the meeting. He had been impressed by the characteristic attitude of Imperial Chemical Industries in convening this meeting in their own premises and demonstrating their desire to co-operate and to discuss a very important matter both from the point of view of the foundry and also that of Imperial Chemical Industries. This seemed to him to be an excellent example of co-operation in the real sense of the word, because the British Cast Iron Research Association was a *co-operative* body.

(To be continued.)

Institute of British Foundrymen.

SCOTTISH BRANCH ANNUAL DINNER.

The annual dinner of the Scottish Branch of the Institute of British Foundrymen was held in the Grosvenor Restaurant, Glasgow, on December 3. Mr. H. Dudley Campbell, the Branch-President, occupied the chair, and was accompanied to the high table by Bailie John Henderson, who represented the Lord Provost of Glasgow; Mr. Victor Stobie, President of the Institute; James Galt, Provost of Paisley; Mr. W. Scott, of Newcastle; Mr. Wm. Wallace, Edinburgh; Major T. G. Bird; Professor Robert Hay; Mr. T. Makemson, secretary of the Institute; and Presidents of kindred institutes.

After the loyal toasts had been honoured,

MR. W. SCOTT, in proposing "The City and Corporation of Glasgow," said that it afforded him a great deal of pleasure to propose the toast. It was claimed for the city that it was the second in the Empire, but he believed that for foresight and push it was the first. That was the third visit which he had made to the city; upon the first occasion he formed the opinion that the Corporation knew their job, and was looking after the affairs of the town. On his second visit he had the opportunity of going down the river, and he formed the opinion that Glasgow must be the first city of the Empire as regards shipbuilding. After meeting a number of Glaswegians he felt sure that they had the right qualities to combat the present troubles and to manage the affairs of the Corporation to the honour and benefit of all concerned. He had very much pleasure in submitting the toast of "The City and Corporation of Glasgow," coupled with the name of Bailie Henderson.

English Pipes for Scottish Cities.

BAILIE HENDERSON, in replying, said that he had first to express the regret of the Provost at being unable to be with them that evening. The Provost had two other engagements, and had asked him as the second senior magistrate to deputise for him. He was not a pessimist, but he believed that the city suffered through their own people crying down their own city, and the consequence was that people in the South got an exaggerated idea of their condition and pictured Glasgow as a city of poverty and disturbance. There had been in the past equally troublesome times, but then men in authority faced up to it, and they were after able to enjoy the sunshine. The present depression was not national, but international, and he believed that the tide was now turning. He happened to be chairman of the Water Committee, the Council Committee which gave the greatest value for money, but, unfortunately, when they wanted a supply of 12-in. cast-iron pipes, they had to go to England for them. He thought it very strange to find that, in the case of what used to be one of the staple industries of the district, when the City of Glasgow came into the market, they had to go to England to obtain supplies. He had been told that they required a certain ore which was not found in Scotland, only in England, and the blast furances had to go there, but he was not satisfied with that story. Why did they not acquire those fields, and then have compelled the English to come to Scotland for their material? He charged the Scottish foundrymen connected with the production of cast-iron pipes of want of enterprise and letting what used to be an important industry slip from them. He remembered being invited to the opening of the new works at Staveley for the production of spun pipes, and he was honoured by being asked to propose the toast of prosperity of that work. Although it was an honour and a pleasure to speak at that function, he realised all the time that the Corporation were helping to pay wages to workers in England instead of in Scotland. He wished to exhort the Scottish founders to pull themselves together and endeavour to resuscitate the pipe industry. There was much talk about bringing new industries to Clydeside, and they needed something new, but they also wanted to keep the old ones, which must be reorganised and brought to prosperity in the old city of St. Mungo, on the banks of the Clyde.

An Ever-Changing Industry.

MR. JAMES GALT, Provost of Paisley, in proposing "The Institute of British Foundrymen," said he was now one of a very small and diminishing band whose membership dates back to the year 1904 when the Institute, under its old name of the British Foundrymen's Association, was formed. There were now only seven whose membership goes back to that year, and in these days when it is the fashion to compare closely the ratios between Scotland and England, he thought the figure works out very well in our favour. He believed the ratio was something like eleven-eightieths, say one Scot to eight Englishmen, but as there are two Scots in the 1904 survivors the proportion is two to five, and that would seem to indicate that in 1904 they in Scotland had a better idea of the advantages to be obtained from the Institute than these in the South. He was glad to know that the other Scot, Mr. Rankin, of Alexandria, was still continuing the good work of carrying on his foundry practically in the Highlands. From 1904 to 1932 is, perhaps, not a very long time, but in that time the Institute has been able to gather within its membership most of those who are in any real sense interested in the development of foundry work. That was a much more difficult matter than most people think, for the foundry interests were exceedingly diverse. To be able to cater for all those interests and to retain in active association those whose interests are confined to only one of them is the task that faces the general as well as the Branch Councils of the Institute, and the success that has been achieved could best be gauged when one remembers that the technique of these things was constantly changing, and that the Institute to-day was the only satisfactory medium through which the ordinary founder could be kept acquainted and informed of these changes. But the Institute was doing more than that. It had been a pioneer in realising that technical advances were not confined and cannot be confined to any one country, and so it has taken a foremost part in furthering an international spirit amongst foundrymen, which had the effect of making for the standardisation of test-pieces and specifications, and relating the foundry problems of this country to those of America and European countries.

Progress Achieved.

MR. VICTOR STOBIE (President of the Institute), in replying, said: It was with the greatest possible pleasure that he responded to the toast of the Institute so kindly and ably proposed by Provost Galt. It was specially delightful to find among the Corporations men with so much knowledge of the Institute. He did not propose to review too many of the excellent directions on which the labours of the Institute were concentrated, all are known to the majority here, and he would therefore just touch some points which would give those who were not members some idea of this work and those who were members some cause for pride. The Institute is forging ahead not with the times but very much ahead of them. What he meant by that was they were not being carried forward by the ordinary advance of the industry but they were leading the industry—definitely. Quite a number of the Papers delivered at their meetings and discussed were explorations not merely of known territories, but of previously unknown ones, frequently even unexpected ones. The results of these labours were snatched up by the industry soon afterwards. You all have been present at the discussion of Papers when one or more members have expressed themselves in words such as "A brilliant Paper; it explains things we have all observed but of which there has been no previous explanation." One large manufacturer of marine engines once told him that he knew of no technical college which developed the science and art of founding in the minds of those interested to anything like the same extent as did the Institute. The Institute has launched, perhaps, its greatest gift to the industry by creating a year or so ago its Technical Committee. The first published report from that Committee was given, as you will remember, at the June Conference. As a foretaste of the intrinsic worth of that Committee it would be difficult to conceive a more promising sample.

One of the most important labours of the Technical Committee will be the interpreting of all the research work of modern times into terms applicable to the actual work of the scientific student and the craftsman. The Technical Committee would be the collecting ground of all that knowledge which, fed into the machinery of the industry, would push forward the future quality and economics of British founding. It was composed of many of Britain's foremost leaders in their special sections of metallurgy. It would bring to the members of this Institute a service which a sum equal to the whole income of the whole Institute would not purchase for them in any other way. He would, indeed, be a sad man in the industry who did not avail himself of the coming resources of the Institute.

In another direction the Institute had recently accomplished a great feat. The newly-launched certificates awarded by the City and Guilds of London Institute following examinations in founding had been a remarkable incentive to day and evening students in technical colleges throughout Great Britain. The number of certificates which have been won has exceeded all expectations. The same applied to the certificates for patternmaking. The National Certificates awarded by the Institution of Mechanical Engineering and the Board of Education were still more difficult to obtain, but here again they had been rewarded by seeing a considerable enthusiasm aroused in these all over the country. The Institute set the wheels in motion to create these different awards for prominence in founding, and all the certificates awarded are countersigned by the President of this Institute. He had the pleasure recently of signing more than fifty of them. One silver and two bronze medals were also gained by the excellence of candidates' work. Of particular interest is it to us to know that Mr. Walker, the hon. secretary of the Sheffield Branch of this Institute, gained first place in Great Britain in this section of work.

Meeting the New Conditions.

MR. WILLIAM WALLACE, in proposing "The Technical and Educational Institutions," said that all societies had a similar toast of kindred institutes or clubs. He happened to be a member of the Council of the Institution of Engineers and Shipbuilders, and knew of the large amount of work done by the various institutions. They in Glasgow were particularly well off as regards technical societies and educational establishments. The recently-formed Association of Secretaries and the joint syllabus which had been issued of all meetings held in the West of Scotland made available an enormous fund of information. The young foundrymen wanted all that information to-day. Specifications which engineers were issuing to-day, demanding condi-

tions undreamed of a few years ago, demanded up-to-date information. Working had to be exact, and to very narrow margins; there could be nothing approximate in the methods of the foundrymen to-day, and so he made use of all the information put at his disposal by technical and educational institutions.

PROF. ROBERT HAY, in replying, said he had often wondered how it was that the local Branch could meet on a Saturday and get such a big attendance. In regard to industry, Bailie Henderson had expressed the fear that the foundry industry was dying in this country. Scotch blast furnaces were perhaps not the last word in iron production, but there was a furnace making 1,100 tons a week at a price competing with the lowest in Middlesbrough; this was because the owner had applied a scientific brain to the problem, and the Institute was fortunate, and the Scottish Branch in particular, in having members who could apply a scientific brain to industry.

A Field for Development.

MAJOR BIRD, in proposing "The Scottish Branch," said that his acquaintance with the Institute was rather limited, but he understood that the Scottish Branch was the second largest in the country. Mr. Campbell, the President, like himself, drifted from the engineering side to the foundry, but he did not know why, because it meant leaving a bed of roses for one of thistles. The foundry side was not appreciated, and the Institute should impress on the engineering side that they were the people who matter. He could take a moulder to the machine shop and soon have him working the machine as well as the engineer, but he could not take the machine-shop man to mould. The foundry was the heart of the industry, the engineering side was only the arms and legs. It was possible to get along without an arm or a leg but not without a heart. He thought also the drawing office should be made to understand the foundry point of view. The drawing office were very keen to draw nice curves and square corners, and in educating the draughtsman to the founders needs was where the Institute could do sterling work.

MR. CAMPBELL, Branch-President, in replying said there was a field for the engineer in the foundry but he should have a preliminary training in the foundry, because if there were no foundries there would be no engineering. The troubles and trials of an engineer were a mere nothing compared to those of a foundryman. An engineer who has been accustomed to think all that is required is to keep everything nicely oiled finds a different set of problems in the foundry where he has to deal with gases and dust and sand. It would be necessary to bring in all sides as the problems of the founder were going to be more strenuous in the future and the education of the founder is specially important because, as Mr. Wallace mentioned, there is going to be no approximate working.

MR. T. MAKEMSOM, General Secretary, proposing a vote of thanks to the artists, said that he thought the Scottish branch were always ready to have a shot at anything which was likely to enhance the work of the Institute and recently they had carried the attack right into the capital itself, the meetings in Edinburgh were proving very successful and he hoped foundrymen there would respond to the efforts to bring the benefits of the Institute in their midst.

During the evening songs were given by Messrs. J. C. Dorsie, James Miller, Tom Miller, Thos. Troctor and Harry Robertson. Mr. John Easton acting as accompanist.

THE BRITISH STEELWORK ASSOCIATION and Imperial Chemical Industries, Limited, have set up a joint committee of investigation to study the various problems presented by the adaptation of modern methods of design and modern materials in the production of cheap and efficient structures.

Manganese Ore in South Africa.

POSTMASBURG DEPOSITS.

In the course of his presidential address before the Chemical, Metallurgical and Mining Society of South Africa recently, MR. T. NIMMO DEWAR, referring to the subject of manganese ore, stated that the discovery of manganese ore in the Postmasburg district several years ago again raised hopes of establishing a new and profitable industry in which the mining and exporting of ore, coupled with the production of ferro-manganese within the Union, would play an important part in developing the mineral resources. When manganese was first discovered at Postmasburg, the iron and steel industries of the world were booming; the consumption of ferro-manganese was at a high level and the price of both raw ore and ferro was most attractive. But the production stage had barely been reached when the present depression struck the world; there was a sharp falling-off in tonnage requirements, and the price gradually dropped to a level which made it difficult, if not impossible, for South Africa to compete. The position in the manganese market was also aggravated by the dumping of ore from Russia at low prices, with the result that for the time being South Africa had been virtually forced to suspend production.

Since the commencement of production in 1929 to the end of 1931 (continued the speaker) a total of 175,011 tons of manganese ore had been produced from these new fields, having a value of £220,655. There was no production during the first half of the present year. The future of the manganese industry was difficult to foretell, and here again this appeared to be totally dependent on a general revival of trade so as to bring about increased activities in steel manufacture throughout the world. Excepting perhaps in Russia (which was an unknown factor), manganese ore was not over-plentiful in the world, and, strangely enough, the iron- and steel-producing countries of to-day were, almost without exception, devoid of this very important and necessary ore. The possibilities of supplying Canada with its requirements of manganese ore must be followed up by government and private interests.

South Africa was unfortunate in having to compete against British manganese interests in both India and the Gold Coast, otherwise their position as a future supplier within the British Commonwealth might be vastly different. Provided care was exercised in producing a suitable grade of ore, there was reason to believe that South Africa would ultimately obtain a satisfactory footing in the world's manganese market.

For some time past the possibilities of producing the ferro in South Africa had been studied by various interests, but the prevailing low world price of this metal had ruled such a prospect, temporarily at least, out of the question. Had the market remained normal, it was probable that the Union Steel Corporation would have embarked on the production of ferro-manganese some little time ago at its Newcastle works.

There was still much difference of opinion in regard to the resources of the Postmasburg field to meet the requirements of large-scale production, and unfortunately the conflicting theories were not easy to reconcile in the present very superficial state of development of the various occurrences. Without attempting to raise any controversy on the subject, the speaker said that the resources were sufficiently adequate to meet any share of the manganese business of the world which was likely to come their way.

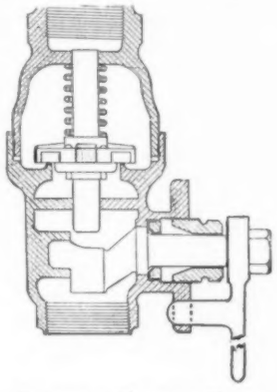
THE NOMINAL CAPITAL of the Enfield Rolling Mills, Limited, has been increased by the addition of £450,000 in £1 ordinary shares beyond the registered capital of £50,000.

New Compressed-Air Valve.

DESIGNED TO PREVENT WASTE.

For use in shops and foundries, as well as in railroad yards and engine houses, an American firm has devised the air valve illustrated, which, in stopping air leakage, is said to reduce the cost of both air and maintenance.

The valve is of sturdy construction and the design is such that it cannot be left partly open, because the instant the cam is turned past centre the pressure and spring close the valve, which is held tight, as well as closed, by pressure. The spring is an auxiliary in case the



SECTIONAL VIEW OF VALVE.

valve is installed in a horizontal or diagonal position. The valve cannot be forced or jammed at the seat, because the instant it is down the cam is disengaged. The vertical action is emphasised as eliminating friction at the seat. Regrinding is not required. Tested under 100-lbs. pressure one of these valves is said to have been still tight after being opened and closed 30,000 times at the rate of 40 full operations a minute.

The valve disc is easily renewed if necessary, and the gland or stuffing box can be repacked without removing the valve from the line or shutting off the air. The camshaft is of hard bronze and the operating handle is of steel; other parts are of red brass. Sizes range from ½ to 2 in. The valve is not recommended for water because of its quick closing and possible shock to the pipe line.—"The Iron Age."

British Steel in Scandinavia.

The delegation of British iron and steel manufacturers to Denmark, Sweden and Norway has now returned to England, and Mr. F. C. Fairholme, the chairman, said on Saturday that the delegation was very well received in all three countries. The object with which the delegation was despatched by the National Federation of Iron and Steel Manufacturers was to inquire into the position of British iron and steel exports to the several markets, and by full and frank discussions with representative groups of buyers and others there to ascertain how the British share of the purchases of iron and steel could be developed and increased to the advantage of both sides. The delegation met representatives of the State and municipal purchasing authorities, leading industrialists and important associations of manufacturers and merchants, as well as a number of local representatives of British firms, and found good reason to hope that their visit to each of the three countries will result in mutual advantage.

WILD-BARFIELD ELECTRIC FURNACES, LIMITED, London, N., and Birmingham Electric Furnaces, Limited, Erdington, Birmingham, have recently reached an agreement between themselves for the interchange of information and rights under their respective patents and patent applications relating to electric furnaces employing contrifugal fans, and to the air-circulation methods used with such fans.

XUM

Some Aspects of the Selection of Engineering Materials.*

By L. B. Hunt, A.R.C.S., M.Sc.

The study of metallic engineering materials and the selection of suitable from unsuitable materials for the various duties they are called upon to perform, clearly covers the whole field of physical metallurgy as well as certain related branches of science and engineering. In a subject so wide, it is only possible in one short Paper to present certain aspects of the general situation from one's own particular point of view. Certain phases of this subject have recently received considerable attention by discussion before both our own and other societies. In particular there have been the discussion on Testing of Castings before the Institute of Metals last March, the Paper by Dr. Gough on "The Efficacy of Testing Methods" presented to this section at about the same time, and a lecture given by Prof. H. F. Moore, of Illinois, to several of the American societies on "Test Results and Service Values." The particular side of the subject with which it is proposed to deal, however, is somewhat different from those discussed by these authors. The point of view is that of the metallurgist associated with an engineering firm engaged in the large scale manufacture of private and commercial motor vehicles, whose functions include the choice, specification and examination of a wide range of metals and alloys to withstand severe stresses of a complex nature.

This type of work involves a limited knowledge of the whole field of physical metallurgy, without the detailed knowledge and skill of a worker in any one class of material, and inevitably leads to a comparative outlook and a search for fundamental conceptions. The task of deciding upon and maintaining the standards of quality must be based on a knowledge of the stresses to be met in service on the one hand, and of the limitations imposed by the methods of production of the raw materials on the other, if these materials are to be employed to the best advantage.

Tendencies in Engineering Practice.

In endeavouring to bring out some of the principles connecting engineering practice and physical metallurgy in this way, the author will confine himself to considerations of the general stress-resisting properties required for the transmission of energy and the maintenance of the structure. There are naturally a number of special properties necessary for automobile materials to possess, such as wear and corrosion resistance, anti-friction properties and heat conductivity, but these introduce complex factors with which it would be impossible to deal in one Paper, and attention will therefore be confined to the essential requirements of all materials of construction.

The tendency in automobile engineering is, of course, in the direction of higher performances and increasing stresses, and greater power/weight ratios, and whilst this tendency is being met by the continual improvement of the raw materials employed, the problem of their proper selection remains one of considerable responsibility. The preliminary choice of an alloy has to be made in conjunction with the designing engineers, detailed specification must be drawn up, stating as far as possible in measurable terms the properties necessary for satisfactory service, and examination, mechanical, chemical and microscopic, must be carried out in accordance with the specification. Considerable experience has naturally been acquired both by designing engineers and by manufacturers, of the service values of engineering materials, but it is still the duty of the engineering metallurgist to form the connecting link in the selection of the most suitable material at the lowest possible cost. Further, experience is not always a sufficient basis for judgment, and advancing knowledge and research must be utilised wherever possible to keep pace with increasing stress requirements and more severe working conditions. It is with this application of fundamental knowledge (obtained by patient investigation) to the problems of selection of engineering materials that the Paper will be chiefly concerned.

The Engineer and Specifications.

From references to the engineer in certain metallurgical publications, one is left with an impression of an aloof and not very intelligent person, rather resembling an income tax collector seated in an office decorated with framed copies of British Standard Specifications, and issuing his final demands, not in pounds, shillings and pence, but in tons per sq. in. Actually, of course, the engineer is quite a different person—willing to come to a gentleman's agreement, provided he is still confident of the reliability of his materials. The ideal specification would cover the best material for the purpose intended, and the only material suitable for such purposes, or in other words would represent the truth, the whole truth, and nothing but the truth, of what is required. There would be a necessity either of service or of production, and based on experimental evidence, behind each requirement, and here our specifications generally depart widely from the ideal. Because an alloy falls outside some arbitrary limits of chemical composition or physical test, it is liable to be rejected, although there may be no proof whatever that it would not be suitable for service. Detailed experimental results on the influence of any one constituent on the actual service value of an alloy are seldom available, and the metallurgist is thrown back on his judgment in the difficult problem of drawing the line between suitable and unsuitable material.

There are, of course, many standard specifications in existence, covering numerous metals and alloys, but these are often not sufficiently stringent, and in any case are issued only after considerable experience has been obtained, or do not recognise different grades of the same material. In any case, selection of a material for a given part often depends upon factors which must be considered in detail by the metallurgist in direct contact, rather than by a committee, however expert, representing the industry in general.

In the case of large-scale automobile work, there are two advantages which are not often enjoyed by the heavier engineering industry. One is that new materials can be given extensive service trials in experimental cars, and the other lies in the use of that beautiful but often meaningless procedure known as the test to destruction. Apart from these, however, it is necessary to decide upon the properties of a material which will determine its behaviour in service, and then upon which of the conventional mechanical tests and analyses are to be applied to it in order to reveal to what extent these required properties are present.

The Interpretation of Test Results.

Now the properties of materials by which they resist complex service-stresses for a considerable length of time cannot be measured or recorded in simple terms, and metallurgists have consequently adopted a set of vague terms such as strength, toughness, hardness, to express these properties. The comparatively few tests which are available will reveal certain types of weakness, but they cannot offer a complete guarantee of suitability, and their relation to service requirements is often obscure. On the other hand, there must obviously be a considerable amount of intrinsic value in these tests, and it is therefore desirable to employ them to the best advantage, and to interpret the results on a sound and logical basis.

Many attempts have been made, and are unfortunately still being made, chiefly by persons who are not metallurgists, to derive numerical values, called variously quality factors, merit numbers, or formulæ, to represent the service values of a metal in terms of the results of two or three tests, or the amounts of various elements present. It cannot be too strongly emphasised that juggling with ultimate stress or yield point in tons per sq. in., and elongation or reduction of area in percentage, or with total carbon and silicon percentages, whilst ignoring other equally important factors, cannot possibly be of real value in estimating the suitability of a material. Almost as bad is the habit of dividing maximum stress by specific gravity in order to obtain what is known as the specific tenacity of the light alloys. The resistance of a metal to a given set of service conditions is based on factors which cannot be expressed as numerical quantities in this arbitrary way.

In order to arrive at a more logical basis for the interpretation of test results, it is first necessary to realise that the simple mechanical properties measured by these tests are themselves somplex as compared with the fundamental properties and physical constants which actually determine the behaviour of metals. Consequently in searching for this logical basis a direction must be taken opposite to that taken by the exponents of merit numbers, and imitation tests. The mechanical properties of a metal must be analysed as far as possible into still more simple properties based on their ultimate structure. This process naturally presents considerable difficulty in view of our as yet imperfect knowledge of these simple properties, but considerable progress is being made by means of work such as that on single crystals of pure metals carried out by Sir Harold Carpenter and his colleagues, and by Dr. Gough and his colleagues at the National Physical Laboratory.

It is therefore proposed to use as a frame of reference for the evaluation of test results and analyses, the mechanism of stress resistance in metals, and of failure by deformation and rupture. This procedure will admittedly lead to a qualitative interpretation only, based on a mental picture of what happens to a metal under load, but this, used with judgment, is far preferable to a misleading quantitative expression. Further advantages attaching to this method are its comprehensiveness, and the ease with which features common to all types of alloys can be brought into line.

Mechanism of Failure in Metals.

The statement has often been made that the remarkable property of metals is their softness rather than their hardness. The magnitude of the cohesive forces or true tenacity is known to be far in excess of any values obtained for apparent tenacity in the tensile tests. The explanation of this discrepancy is to be found in the simplicity of the crystalline structure of metals. It was first shown by Ewing and Rosenhain in 1899, and has since been abundantly proved, that metal crystals may be deformed beyond the elastic limit by a kind of block-movement, under stresses much less than those corresponding to their true cohesive strength.

* A Paper read before a Joint Meeting of the London Sections of the Institute of British Foundrymen and the Institute of Metals, Mr. H. G. Sommerfield presiding.

There are in the crystals certain planes of weakness on which resistance to shear is low, and movement may take place under load by a kind of gliding or slipping action on these planes, resulting in permanent deformation of the piece of metal as a whole. This slipping action, however, appears to increase the resistance to further slip, the movement halts after quite a small displacement on any one plane, and slip is forced to take place on other planes, for which higher stresses are required. As loading increases, this slipping continues until a point is reached at which no further slip can occur, owing to the exhaustion of the supply of possible planes, or the disorganisation and distortion of the planes on which slip has been occurring. Actual separation will then occur, starting from some point which is particularly highly stressed owing to this distortion of the slip planes, and spreading rapidly owing to the local concentration of stress at the ends of the discontinuity formed. Rupture does not therefore take place in such a way that the forces which hold the metal crystals together are overcome simultaneously.

This simple description of failure applies particularly to such comparatively straightforward forms of stressing as are met with in the tensile test. In engineering service, however, failure rarely or never occurs in simple tension, and certain modifications of this view must be made, although the mechanism of failure remains essentially the same, whatever the form of loading. Nearly all engineering failures are brought about by repetitions of stress, or by local concentrations of stress, acting either singly or together. So far as it is possible to visualise the process of failure due to repeated stresses, known as fatigue failure, and here the profession is indebted to Dr. Gough for his painstaking efforts to throw light upon this problem, it appears that the constant very slight deformation in some particularly favoured crystal causes a buckling or rumpling of the slip planes until a stage is reached at which a very minute discontinuity or crack is formed in the direction of slip, when further repetition of stress will cause gradual spreading of the crack until fracture is complete.

In the case of a load applied to a component having an appreciable change of section, or in any other way liable to stress concentration, the elastic limit or yield point may be exceeded locally, and deformation must take place, tending to reduce the local value of the stress. If this local deformation is prevented, or if a pronounced resistance to shear is developed, the exceedingly high local stress may overcome the cohesion of the metal, and the well-known brittle fracture will result.

Cohesion and Slip.

These very brief considerations lead to the conclusion that failure in any form is a function of the relationship existing between the resistance of a metal to slip, and its true cohesion. Rupture is preceded by slip, if only by a very small amount of slip, and cannot in fact take place whilst slip is still possible. In order for slip to take place, cohesion must clearly be greater than resistance to slip, but when further slip becomes impossible, actual separation is brought about by the exceptionally-high stresses set up exceeding the cohesion locally. The crystalline cohesion of a metal is a physical constant of the highest importance, depending upon the crystal structure, and it is not appreciably altered by the addition of other elements in reasonably small amounts. It is reflected in such properties as melting point, coefficient of expansion, atomic volume, and modules of elasticity.

TABLE I.—*Cohesional Properties of Metals.*

Metal.	Modulus of elasticity lbs./sq. in. × 10^6.	Melting point, deg. C.	Coefficient of expansion × 10^{-6}.	Atomic volume.
Magnesium	6.5	651	25.9	13.3
Aluminium	10	658	24	10.1
Copper ..	18	1,083	17	7.1
Iron ..	30	1,500	11	7.1

From Table I some idea can be obtained of the limitations of the metals used as the bases for engineering alloys. These cohesional properties put definite limits to the range of mechanical properties to be obtained by means of combinations and permutations with other metals. The great value of iron as a basis for constructional materials is clearly shown, and the disadvantages attaching to the use of aluminium and magnesium on the score of low rigidity and the low resistance to slip which is possible. In addition to this ultimate crystalline cohesion, there is also the inter-crystalline cohesion to be considered. This normally bears a direct relationship to the true cohesion, but is very susceptible to the presence of impurities in the grain boundaries, which may give rise to excessive brittleness.

Faced with these limitations of cohesion then, the problem of the metallurgist becomes one of improving the resistance to slip in his structural materials by putting difficulties in the way of the slipping movements which lead to the formation of discontinuities, or, in the language of the tensile test, raising the elastic limit and yield point. (The term elastic limit is here used without exact definition.) Concurrently, of course, the engineer will, or should, try to select alloys on the same principle, and it is proposed therefore to briefly run through the methods which are available for opposing this slipping and subsequent failure before going on to consider the suggested basis for the selection of materials.

The Methods of Slip Resistance.

Now the amount of slip will be governed by the smoothness and extent of the slip planes, and thus the resistance to slip may be increased by either roughening these planes in some way, or by limiting their extent, or by both methods together. The extent of the slip planes may be considerably reduced by a reduction in the grain size of the metal. When slip takes place in any one grain, it cannot continue into the next grain without changing direction, and deformation is thus resisted. Probably the best example of this principle in non-ferrous foundry work is the modification process for aluminium-silicon alloys. This method of grain refinement was shown by Gwyer and Phillips to be applicable to several other alloy systems, notably the lead-antimony and antimony-copper alloys. Somewhat similar effects are obtained by the presence of small amounts of iron, manganese and aluminium in the high tensile brasses, by the addition of titanium and molybdenum to cast iron, and of titanium to certain cast aluminium alloys. The mechanism of this curious process of grain refinement, generally brought about by a small amount of the added metal in solid solution, is still undiscovered, but the method is being employed to a considerable extent at present, and will probably find much wider application when the mechanism is revealed.

The other method of increasing slip resistance, by the roughening of the slip planes, has been shown by Dr. Rosenhain to be brought about by the addition of a second metal which will enter into solid solution. Since the atoms of the two metals will not occupy the same space, or field of force, a general slight displacement will occur, which hinders the commencement and propagation of slip. In other words, the elastic limit and yield point are raised. This principle is the basis of practically the whole of physical metallurgy as applied to engineering materials. The relative effects of various added metals are approximately a function of their solid solubility. In copper, for instance, a more soluble metal, such as zinc, will have relatively less strengthening effect than a less soluble metal, such as tin or aluminium.

Further strengthening effects may be obtained by playing upon these solubility relationships at various temperatures, either by simple quenching in order to retain some particularly valuable structure which is stable at high temperatures, or by quenching to take certain constituents into solution, followed by a lower temperature treatment to impart a tendency to their removal from solution in an exceedingly finely divided form.

These processes are entirely dependent on the thermal equilibrium diagram of the system. If one particular constituent is found to have appreciably greater solubility at high than at low temperatures, then the possibility of this precipitation or age-hardening process is indicated. The high temperature solid-solution may be retained in a supersaturated condition by quenching, whilst the subsequent reheating will tend to cause separation of the excess of the solute in a finely divided condition. This process was first utilised in the case of Duralumin, but without any recognition of the actual mechanism involved. Subsequent research, both at the National Physical Laboratory and in the United States, served to explain the phenomena, and this has been followed by further applications of the same principle to other aluminium alloys, and also to certain copper alloys containing beryllium. The process is in fact becoming one of the most important tools in the hands of the metallurgist, in the improvement of old engineering alloys and the introduction of new.

Presence of a Second Phase.

A third method of causing interference with slip is by means of a combination of the previous two, *i.e.*, by the formation of a second constituent. If a metal such as zinc is added to copper until its solid solubility is exceeded, a second phase will be formed, known as the β solid solution. This constituent, besides being inherently harder, or possessing considerable resistance to slip within its crystals, causes a reduction in the extent of the slip planes at the boundaries between the two constituents. By far the greater proportion of engineering materials consist of these duplex alloys, and by reason of the more complex crystalline structure of the second phases making them more resistant to slip than the pure metals and simple solid solutions, their amount and distribution must be controlled with care. Although usually in the form of a secondary solid-solution, the second phase may also consist of an intermetallic compound. These substances possess a much more complex crystal structure, and are not subject to the mechanism of slip. In other words, they possess great inherent hardness and brittleness, and if present in sufficient quantity will impart these properties to an alloy. If, on the other hand, their amount and distribution are under careful control, these compounds are invaluable as a means of improving the stress resisting properties of metals, as in the precipitation hardening processes mentioned previously.

Compounds may be present as separate constituents, as in the case of the tin-antimony and tin-copper compounds in tin-base bearing-metals, but more often they are found to constitute part of a eutectic or eutectoid, as with $CuAl_2$ in aluminium-copper alloys, and the cementite constituent of pearlite in steel and cast iron. It is in these cases that the most careful control is necessary in order to obtain the optimum properties of an alloy. Very small variations in the carbon content of steel, producing, however, considerable differences in the amount of the eutectoid pearlite present, will have marked effects on the properties of the steel. It is thus often necessary to impose overall limits of 0.05 per cent. on the carbon content of certain high duty steels, although for many purposes an extreme variation of 0.10 per cent. is permissible. In these cases, however, there is an accurate knowledge of the permissible variations and their effects on both service properties and production processes.

(To be continued.)

D

XUM

Institute of British Foundrymen.

LONDON BRANCH ANNUAL DINNER.

In spite of the depression, and the fact that the London Branch covers a very large area—which means that many of the members have to travel great distances to London—the annual dinner of the Branch, held at the Charing Cross Hotel, was well attended, and proved to be the usual jolly function.

Mr. H. G. Sommerfield, C.C. (Branch-President), was in the chair, and the guests and members present included Sir Henry Fowler, K.B.E. (President, Institute of Metals), Mr. Victor Stobie, M.I.E.E. (President of the Institute), Mr. S. L. Archbutt, F.I.C. (chairman, London Section, Institute of Metals), Mr. Barrington Hooper, C.B.E., Mr. Wesley Lambert, C.B.E. (Past-President of the Institute), Mr. W. B. Lake, J.P. (hon. treasurer of the Institute), Maj. A. C. Vivian, Mr. K. W. Bridges, Mr. C. H. Kain (Branch Vice-President), Mr. A. S. Beech (Branch Vice-President), Mr. V. C. Faulkner (Past-President of the Institute), Mr. J. G. Pearce (director, British Cast Iron Research Association), Mr. A. F. Gibbs, Mr. H. O. Slater and Mr. J. W. Gardom (Past Branch-Presidents), Mr. A. W. G. Bagshawe, Mr. T. Makemson (general secretary of the Institute), Mr. H. W. Lockwood (hon. secretary of the Branch), Mr. W. Haddock, Mr. V. Delport and Mr. W. O'Keefe.

During the evening the loving cup which was presented a few years ago by Col. W. Cheesewright (a pioneer and devotee of the Branch) was passed round.

THE TOASTS.

Progress in Foundry Practice.

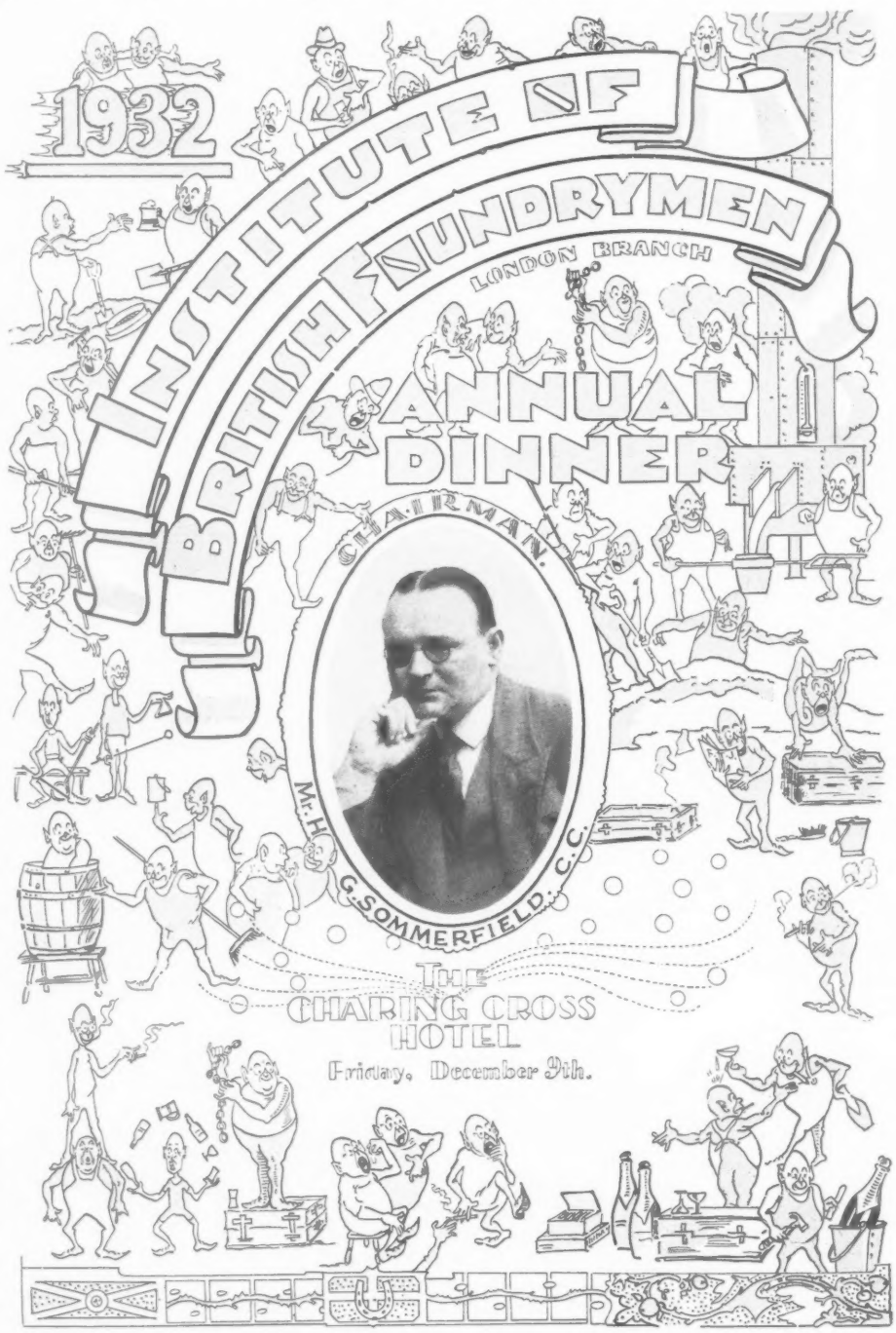
The loyal toast having been honoured, Sir Henry Fowler, K.B.E., proposed "The Institute of British Foundrymen," and said that probably he had been invited because he held the honoured position of President of the Institute of Metals. He was very proud indeed of that position; it had conferred upon him many pleasures, of which this annual dinner of the London Branch of the Institute of British Foundrymen was not the least.

Sir Henry recalled that he had been a teacher of metallurgy, and he was proud that one of his students had become Vice-Chancellor of one of our universities. Any who had taught at technical colleges would appreciate that few things gave a teacher greater pleasure than to hear of the work of his own students.

During his seven years' service as a craftsman he had not worked in the foundry; he had been a metallurgist, as well as a fitter and a millwright, and had enjoyed the work thoroughly. He was proud to think that when he was Chief Mechanical Engineer to the L.M. & S. Railway, the foreman of the company's foundry at Derby (Mr. Pemberton) was chairman of the Midland Section of the Institute, and he was glad to learn recently that at the technical college there another great foundryman (Mr. Bunting) was giving his assistance.

Sir Henry went on to comment upon the great improvements that had been effected in castings of all descriptions, including malleable castings, in recent years, and said that if he spoke as he felt with regard to his old friend Mr. Pearce (the Director of the British Cast Iron Research Association) the latter would blush. A great deal of good work had been done by the Research Association, and he expected that before long Mr. Pearce would show that he could produce, and, therefore, the members of the Institute could produce, cast iron which would give a good impact test. But tremendous improvements had been made in other metals as well as cast iron. He recalled a time when, as an inspector, he had been glad when he was able to drop one ton about 2 ft. on to a steel casting for a railway wheel. Nowadays one saw the castings doubled up, and could appreciate how tough and sound they were. The improvements in steel castings represented one of the most marvellous advances in the foundry world in recent years.

With regard to education of the foundry boy, Sir Henry said he had had the honour of being a member of the committee which had drawn up the report for the Board of Education on the education of engineers. The committee had known that the Institute was moving in this matter; though scope remained still, a tremendous advance had been made, and it was due largely to the work of the Institute. During last summer he had attended, with the immediate Past-President of the Institute, the meeting of foundrymen held in Paris, and one of his most delightful experiences there was to watch the distribution of prizes to foundry boys and foundry men. It was inspiring to see the intelligence reflected in the faces of the recipients, and to appreciate the great changes that had taken place, not only in respect of the materials produced in the foundry, but also in the men who produced them.



The Front Cover of the Souvenir Programme.

A Proud Record.

Mr. Victor Stobie, M.I.E.E. (President of the Institute), in his response, said he hoped Sir Henry would not feel that the Institute of British Foundrymen was encroaching upon his

domain when it was stated that the Institute was not merely a body of craftsmen, as it comprised within its membership technicians and scientists.

When they contemplated the considerable labours devoted by the Institute to the development of all branches of the founding industry, such as the scientific investigations now being carried through by the Institute's Technical Committee—so ably fathered by Mr. J. W. Gardom—and its sub-committees, and the examinations in theoretical and practical founding conducted under the Institute's advice by the City and Guilds of London Institute, the Institution of Mechanical Engineers and the Board of Education; when they saw the great enthusiasm which those investigations and examinations aroused in all parts of the country; when they realised the acknowledged help to the industry of so many of the Papers that were read each year before the Branches; when, in spite of the entirely adverse state of finance to-day, they found the membership roll healthier than ever before; was there any wonder that they sat down to this dinner happy in the knowledge of the wonderful success achieved during the twelve months which had elapsed since the last annual dinner? Their success was not due to any change of fashion or to any stroke of luck. It had resulted from the devoted labours of a band of workers comprising the major portion of the 2,000 members of the Institute.

Continuing, Mr. Stobie said that the work of the Institute in connection with examinations, and so on, including the work that was being done through the Technical Committee, represented the Institute's contribution to the world at large. That contribution, however, cost money. The Institute was not so favoured as the Research Association, for it could not get a Government grant, but had to produce the necessary money itself. If the work were to be continued on the lines intended the Institute must have more money; therefore, he took the opportunity to do a little propaganda, and invited all non-members present to give the Institute a little encouragement by joining its ranks. Also, to those already numbered among the saints he appealed that they should do a little more saintly work by showing the Institute's past accomplishments and future programme to non-members whenever possible, with a view to bringing them into the fold, because only in that way could the work of the Institute be accomplished successfully.

FOUNDRYMENS' DINNER TO-NIGHT— MAY BE LATE— TA-TA
WE'LL GIVE YOU SOME CORE GUMS McGINTY
THE DOOR IS OPEN
PROSPERITY
AM I RIGHT FOR THE FOUNDRMENS DINNER?
WHAT WE SHALL SEE IN 1933.
MIND
BLACKING.
CORE OIL.
CORE TAPERS.
BATH CHAPLETS AND CARBORUNDUM BRICKS AND WHEELS.
REFRACTORIES PLUMBAGOES.
HOW TO WIN THE ASHES BACK AGAIN
MORE ORDERS
FACTORIES WORKING AT FULL TIME
LESS UNEMPLOYMENT
HAPPY DAYS!
GET DOWN TO IT!
STOP AT THE CHARING + HOTEL PLEASE!
PUT MORE ICE IN IT
F·T·J SPECIAL No.

THE BACK COVER OF THE PROGRAMME.

The Guests and their Attributes.

MR. C. H. KAIN (Senior Vice-President of the Branch), in a witty speech, in the course of which he made jocular reference to his "distinguished ancestor," Tubal Cain, proposed the health of "The Guests," who included representatives of every interest of importance to the foundry industry. Of the guests he mentioned particularly Sir Henry Fowler, the President of the Institute of Metals, a very distinguished engineer and user of metals. It must have been of Sir Henry that Shakespeare had said "The gentleman is learned, and a rare speaker." Mr. Kain also made special reference to Mr. Stobie, the President of the Institute of British Foundrymen, a steel-maker of very wide fame and a "muffin man" of no mean repute; Mr. S. L. Archbutt, the Chairman of the London Section of the Institute of Metals, and an authority on what were once described as "non-ferocious" metals; Mr. Wadie, a visitor from New Zealand; Major A. C. Vivian, who knew more than any engineer ought to know about cast iron, and who had read a Paper before the Branch on the plasticity of cast iron, from which one gathered that it ought to be sold by the pint instead of by the hundredweight; Mr. Lloyd, of Messrs. Stewarts & Lloyds, who made pig; Mr. J. G. Pearce, the Director of the British Cast Iron Research Association, who was constantly demonstrating that a little research a day kept the wasters away; and Mr. Haddock, of Norton Grinding Wheel Company, who ground away the sharp edges and the roughness from the castings. Mr. Kain extended to them all a hearty welcome.

Helping Along Good Work.

MAJOR A. C. VIVIAN, A.C.G.I., A.M.Inst.C.E., responding, said that to him, as a constructional engineer, there was something rather marvellous about the foundry industry. A foundryman made a hole in sand, poured metal into it and obtained the desired result, and it seemed, indeed, miraculous that, instead of there being a large number of failures, there were so few. The constructional engineer had the advantage that he could check things as he went along.

Commenting on the Paper he had presented to the Branch earlier in the session, dealing with the character of cast iron, and particularly plasticity and elasticity, he said it was based on a certain unconventionality, within defined limits—and, of course, it was desirable that any unconventionality should be within very defined limits. It was made up of a mixture of three things, which he illustrated by quoting various authors. The first was a "tag" by Ingersoll, that "The trouble with most people is that they bow down to what is called authority. They have a certain reverence for the old because it is old; they think a man better for being dead, especially if he has been dead a long time." To combat the somewhat revolutionary sentiment in that, Major Vivian quoted some words of wordly wisdom by Coleridge, that "Truth is a good dog, but beware of barking too close to the heels of a mare, lest you get your brains kicked out." Then, to take the arrogance out of that, he quoted Dodgson, "In

my youth I thought it would injure the brain, but now I have none and I can do it again."

He had been engaged for some years in the study of the chemistry and physics of the cast iron, and, the bar having now been cast, this was the stage at which he wanted expert assistance and advice from the foundrymen. He took the opportunity to say that such assistance as he had needed in the past had always been forthcoming, and that more was promised.

On behalf of all the guests, Major Vivian expressed thanks to the members of the London Branch for their kind hospitality and good fellowship.

How London Technicians Co-operate.

Mr. S. L. Archbutt, F.I.C. (Chairman of the London Section of the Institute of Metals), proposed "The London Branch," and coupled with the toast the name of Mr. Sommerfield, the Branch-President. He appreciated the honour, particularly as it gave him the pleasure of being a guest of the Branch at its annual dinner. The parent bodies—the Institute of British Foundrymen and the Institute of Metals—he continued, had developed healthy offspring in the form of their local sections, to spread the work and aims of the parents throughout the country, and they had reason to be proud of those offspring. It would be agreed that the London sections of the two Institutes could be counted among the healthiest of their offspring.

In the production of engineering materials it became increasingly difficult, with the advance of knowledge, to discover where the functions of the foundryman ended and where those of the metallurgist began—and *vice versa*. Mr. Stobie had emphasised that fact. It could be said, roughly, that the chemist controlled the composition of the metals and alloys; the metallurgist advised on production processes, and particularly on the effects of variations of composition, heat-treatment, etc., on the properties of the finished materials and on the possibilities of new or improved materials. But where would the engineer be without the skill and experience of the foundryman to translate the work of the chemist and metallurgist into industrial practice in the shape of satisfactory castings and ingots? It was obvious that they could help one another, and indeed, that the closest co-operation was essential. That was recognised in the fact that for many years there had been close contact between the London Sections of the Institute of British Foundrymen and the Institute of Metals. Each year they held a joint meeting, each Section being the host in alternate years. On the previous evening the London Section of the Institute of British Foundrymen had been the hosts, and he thanked the members for their hospitality and for the excellent Paper presented on that occasion, dealing with the selection of engineering materials. He was glad that Mr. L. B. Hunt, the author, was present at the dinner. Mr. Hunt belonged to each of the two Institutes, and that fact illustrated again the close contact existing between the two.

Both Mr. Sommerfield and himself were newly-elected Chairmen of the London Sections of the respective Institutes, and both had experienced a period of service as officers of the Sections. Mr. Sommerfield had served as Honorary Secretary of the London Branch of the I.B.F. for eight years, and had an unrivalled experience of the business and activities of the Branch. He was a man of wide experience, including that relating to municipal affairs, and was a Freeman and Liveryman of the City of London; further honour had been conferred upon him recently by his election to the Common Council of the Aldersgate Ward. (Applause.) The members of the London Branch could count themselves fortunate in having a man of Mr. Sommerfield's capacity and experience to guide the affairs of the Branch.

A Tribute to the Secretary.

The Branch-President said men of technical and scientific societies derived great satisfaction from the knowledge that kindred societies were co-operating in the work; they each knew that their own societies could not exist alone. The stupendous work of the British Cast Iron Research Association had been referred to, and there were other associations doing equally laudable work. One was the Foundry Trades' Equipment and Supply Association. That might be a limited company, but it existed for the purpose of doing specific work, and it had undertaken that work very creditably. He felt sure that foundrymen appreciated that they were indebted in some measure to the work of that Association. Again, the Institute of British Foundrymen was allied in more ways than one to the Institute of Metals; many of those connected with the industry were members of both Institutes, and he was glad to welcome on this occasion some of the Past-Chairmen of the London Section of the Institute of Metals.

In this connection the President took the opportunity to pay a tribute to Mr. H. W. Lockwood, the hon. secretary of the Branch, and said that the success of this annual dinner was but one of many of the results of his hard work. The thanks of the Branch was due to him; it was hoped that he would retain his office in future years, and that future Presidents would have the advantage of the same inestimable support he had rendered in the past. That would redound to the benefit of the London Branch, and to the parent Institute as a whole, because, after all, the Branch was an integral part of the Institute, and unless it pulled its weight it represented a weak link in the chain.

Finally, the President thanked Mr. Archbutt for his remarks, and assured him that the Institute and its Branches were anxious at all times to work in unison and liaison with the Institute of Metals in the interests of the whole industry.

Pig-Iron and Steel Output in November.

There were 59 furnaces in blast at the end of November, the same as at the beginning of the month; five furnaces having commenced operations and five having been blown out. Production of pig-iron amounted to 267,700 tons, compared with 275,600 tons in October and 296,400 tons in November, 1931. There was a slight increase in the daily rate compared with October. The production includes 63,000 tons of hematite, 128,300 tons of basic, 66,000 tons of foundry and 7,200 tons of forge pig-iron. The output of steel ingots and castings amounted to 473,800 tons, compared with 439,800 tons in October and 459,200 tons in November, 1931.

Age-Hardening of Metals.—At a meeting of the Institute of Metals (Scottish Section), held last week, Dr. C. H. Desch read a Paper on the "Age-Hardening of Metals," in the course of which he said that the view that the age-hardening of alloys was due to the precipitation of a constituent from solid solution in an ultra-microscopic form was now generally adopted, although the originally simple view had had to be modified in several respects. The precipitation occurred at first in aggregates of comparatively small numbers of molecules, which arranged themselves parallel with certain planes in the original crystal. With increase of temperature, or with lapse of time if the temperature were sufficiently high, these minute aggregates united to form larger masses. In doing so they brought about a condition of strain in the space-lattice in which they were embedded, and it was this strain which was responsible for the increase in electrical resistance often observed, and for a part of the increase in hardness. With further growth of the particles the strain might be relieved. Hence a number of the properties of the alloys passed through maxima in the course of the ageing process, and the maxima of the curve for different properties did not necessarily occur at the same temperature.

The Slump in Copper.

By "Onlooker."

Copper has recently come back again nearly to its previous low record set up in July last, when the price declined to but little above 4½ cents c.i.f. European ports, but in terms of sterling the fall has not been so great, as the £, which five months ago stood at about $3.55, is now some 35 cents lower. The latter stages of this disastrous fall have been brought about by persistent price cutting on the part of Custom smelters, who by offering a comparatively small tonnage each day at ever-falling rates have depressed the quotation in Europe and forced the big producers to fall into line. At the time of writing the price in the States bids fair to fall below 5 cents, while on this side it stands at about 5.12½ cents, a figure really below the American parity if due allowance be made for freight and insurance. In London, standard copper, which three months ago was well on the way to £40, is at the moment but little above £28, other grades, with the possible exception of scrap, being cheap in proportion.

Behind the persistent price cutting by Custom smelters lies the failure on the part of the producers to come to any sort of agreement in regard to curtailment over next year, and of course fears that should the £ fall lower, commodity prices will decline with it. This certainly seems to be the tendency at the moment, and America may yet be forced to the conclusion that in insisting upon payment of the debt instalment due on December 15 she has committed a blunder of the greatest magnitude. One would hardly have thought that with values at 5 cents there was much incentive to increase production, but apparently some of the mines are keen on doing this, though where they expect to sell their copper is something of a puzzle, for demand has practically ceased for the time being. At the back of every fall in copper values we have also the bogey of the huge stocks held in America and the possibility that in spite of the 4 per cent. duty and financing by the banks, part of this tonnage may be thrown on the market.

The background, then, for copper is a very sombre one, and with producers treading on each others' heels, so to speak, in the rush to produce copper which the world does not appear to want, it is not remarkable that the price has fallen away very badly under pressure of selling precipitated by several adverse factors. For the present there certainly does not seem to be any hope for the red metal in an increased rate of consumption, so that, failing an agreement amongst the producers on the subjects of curtailment and marketing, better sentiment arising out of an improvement in international affairs seems to be the only thing likely to help prices upwards. This, it must be hoped, will come one of these days, but it cannot lift copper permanently out of the rut unless an increased rate of consumption comes along to take up the running. Although speculation is certainly not entirely absent from copper it would be wrong to blame bear selling for the present fall in values, for of late operators for the fall have not appeared to be much in evidence. There was, as a matter of fact, up to a short time ago a fairly general belief that copper had seen the worst and that no reaction would go very far, but the international outlook has become so clouded with the failure to settle the debt problem that all calculations have been upset.

That most bad points are discounted at the present level of copper prices is probably true, but that is not to say that the price will not fall lower, for unfortunately there is no certainty that the broad situation as it affects copper will not deteriorate still further. Some day it must be presumed that the *whole* world will realise the vital need to get commodity prices on to a better level, but that happy day does not appear to have dawned yet.

XUM

Tar Oils as Possible Diesel Fuels.*

NEED FOR FURTHER RESEARCH.

There has been marked increase in the use of the Diesel engine within recent years, and a rapid increase is to be anticipated. The application of the light high-speed Diesel engine to road vehicles is quite recent, but already in 1931 there were about 500 Diesel vehicles—buses and lorries—on the road in this country and the number has since more than doubled. Attractions of the Diesel engine are its high efficiency (35 per cent. as compared with 25 per cent. for the petrol engine) and its use of an (at present) untaxed and cheaper fuel which is subject to less risk of fire than is petrol. During the first eight months of 1932, the average declared value of petrol imported into Great Britain was 4.0d. per gall., as compared with 2.5d. for Diesel oil (gas oil) and 1.9d. for fuel oil. The difference in cost to the user is much increased by the incidence of the tax of 8d. per gall. on motor spirit, but it is inevitable that rapid development in the use of the Diesel engine will result in an increase in the cost of Diesel oil. The home price at present obtainable for standard creosote oil is 3.75d. per gall. for home consumption and 4.75d. per gall. f.o.b. for export. An increase in the price of Diesel oil should foster interest in the preparation of tar oils as Diesel fuels should they be reasonably satisfactory. The requirements for such fuels therefore demand consideration.

Desirable Qualities of Diesel Fuels.

Though difficult to specify, there are certain properties of oils which it is desirable that a Diesel fuel should possess. For example, Le Mesurier and Stansfield, as a result of their tests, find that "heavy oils obtained from crudes which give motor spirits of the highest anti-knock value will be the worst from the point of view of combustion shock in a Diesel engine, and that those crudes giving low anti-knock value straight-run spirits will be comparatively good." This conclusion has received wide acceptance. It means, in general, that the best Diesel fuels consist essentially of paraffin hydrocarbons and that fuels containing aromatic hydrocarbons are unsatisfactory.

Foord, in a record of experimental work carried out for the Air Ministry, whilst confirming the conclusion drawn by Le Mesurier and Stansfield, has suggested that the important property of a Diesel fuel, as regards both ease of starting and smooth running, is its "spontaneous ignition temperature." This is lowest for a fuel obtained from a crude petroleum that consists mainly of paraffins, higher for a fuel from a naphthenic crude oil, and highest for a fuel from a crude oil high in aromatics. The spontaneous ignition temperature (in oxygen) of Diesel oils from petroleum range around 250 deg. C., whilst that of creosote oil may be as high as 500 deg. C. Whereas a paraffinic petroleum oil ignites readily in the engine and causes a slow development of pressure on combustion, with a tar oil, which is essentially aromatic, there is a considerable "lag" on ignition followed by a sudden development of pressure which causes "Diesel knock," with rough running and short life of the engine.

The usual Diesel oils are high-boiling petroleum distillates ("gas-oils"), blended sometimes with a certain proportion of "residual." The boiling range does not appear to be of much importance, although Diesel engines designed to run on heavy oils would be subject to loss of fuel through the pump glands if run on a light oil. In general, the Diesel fuels from petroleum have an initial boiling point of over 200 deg. C. and yield up to 90 per cent. on distillation up to 350 deg. C. A high "hard-asphalt" or "free-carbon" content in a Diesel fuel is undesirable because it may result in the choking of the fine filters necessary to prevent abrasive material from entering the fuel pump, or in seizure of the oil-pump and pitting of the exhaust valve.

Performance of Tar Oils as Diesel Fuels.

Considerable experience in the use of tar oils as Diesel fuels was obtained in Germany, before and during the war, and, when there was a shortage of petroleum oils, in this country also. Tars having a high content of free carbon proved unsatisfactory, but thin tars, such as can be obtained from verticle gas retorts, were found to be suitable in slow-speed engines. Since they did not ignite as readily as petroleum distillates, special means of effecting ignition were necessary, the most satisfactory being the injection of a jet of petroleum oil (about 5 per cent. of the charge) as a pilot to the main charge of tar oil. It is possible that the performance of a tar oil in the Diesel engine can be improved by the addition thereto of a "dope," just as the addition of a trace of lead tetraethyl improves the performance of a "pinking" fuel in the petrol engine. Such a dope would have to possess opposite properties to those of lead tetraethyl, inasmuch as it must lower the spontaneous ignition temperature of the oil. No such dope, effective when but a trace is present, has as yet been discovered, but the addition of a comparatively high proportion (about 5 per cent.) of ethyl nitrate (a "pro-knock" for the petrol engine) promotes the smoother running of aromatic fuels in the Diesel engine. The cost of such an addition is at present prohibitive.

With all internal-combustion engines, the lubricating oil becomes diluted to a certain extent by the fuel. This dilution is more marked the higher the boiling range of the fuel. The fuels used in Diesel engines therefore tend to dilute the lubricating oil to a greater extent than occurs with the petrol engine, though this is compensated for to a certain extent by the more complete combustion of the fuel effected in the Diesel engine. When the Diesel fuel used is of petroleum origin, the only effect of dilution of the lubricating oil is a lowering of its viscosity and lubricating power. Creosote oil, however, contains asphaltic substances in solution which are precipitated by ordinary lubricating oils. Frequent changes of the lubricant are therefore necessary, or one of greater solvent power, such as castor oil, can be used.

Summary and Conclusions.

For the modern high-speed Diesel engine an oil of aromatic nature, such as creosote oil, is undesirable, since it is difficult to ignite and causes "combustion shock." The discovery of an effective "dope," however, would remove these objections. Tar oils are of higher oxygen content than petroleum oils and are therefore of lower calorific value per pound. On the other hand, creosote and anthracene oils have higher specific gravities (1.04 and 1.08) than gas-oil (0.82), and their calorific values per gallon are higher.

The difficulty of ignition of tar oils in the Diesel engine can be overcome by providing means of injecting a "pilot" charge of petroleum, but this increases the complexity of the mechanism to such an extent as to be impracticable except with large engines. When it is possible to use this method, a tar oil can be used as effectively as a good petroleum fuel. The effect of the tar oil on the lubricating oil requires to be carefully watched. The design of Diesel engines has been influenced by the properties of the petroleum oils commonly used in them. It is probable that designs of engines more suitable for the combustion of tar oils could be developed, but progress in this direction is unlikely so long as ample supplies of petroleum oils are available at a low price. In the meantime, tar oils cannot be regarded as satisfactory fuels for Diesel engines of normal design.

* From Memorandum No. 7 dealing with developments in the utilisation of coal and its by-products, issued to members of the Institute of Mining Engineers.

Foundry Practice in Belfast.

(*Concluded from page* 379.)

used, it only remains for the foreman to visualise the working to get the desired results, but in a jobbing foundry the making of each casting has to be considered.

Mr. Jameson's final remarks were the stressing of the economical manufacture of castings, but not at the expense of quality. For some years past the demand has been largely for cheap castings, and to produce cheaply, quality must suffer. To-day some foundries use an all-scrap mixture, and owing to this practice it is difficult to get scrap metal which can be relied upon, and if this state of affairs continues, it will be dangerous, in a few years' time, to use even a small proportion of scrap in any casting to be subject to normal strain. Engineers have a great responsibility in this respect and cannot be too particular in their demands upon the foundry.

Magnesite.

Since almost the very beginning of the basic open-hearth furnace, calcined magnesite (magnesium oxide) and calcined dolomite have been used as refractories for the hearths of these furnaces. In fact, it is doubtful if the basic open-hearth process would have reached its present state of development had not basic refractories such as magnesite and dolomite been available in commercial quantities.

Although magnesite has been successfully used for a number of years the properties of this material that have made it the outstanding basic refractory have just been definitely determined. In a series of extensive experiments at Ohio State University it has been found that magnesite can absorb as much as four times its weight of iron oxide and still retain very good refractory properties. It was also found that spinel (magnesium aluminate) can absorb iron oxide in considerable amounts without seriously affecting its refractory properties.

Iron oxide was found to combine with magnesite to form the compound magnesio-ferrite ($MgO.Fe_2O_3$). With spinels, iron oxide does not form another simple compound but forms complex "solid solutions" with varying amounts of ferrous and ferric oxides, depending upon the composition of the original trial piece and its heat-treatment.

The work on magnesite and spinel is described in detail in "Equilibrium Studies in Systems Containing Magnesium Oxide, Iron Oxide, and Magnesium Aluminate" by H. G. Fisk and Wm. J. McCaughey, recently issued as Bulletin 70 of the Engineering Experiment Station, the Ohio State University. Besides the importance of the properties of magnesite and spinel as refractories, the bulletin takes up the possibility of the use of iron oxide to form autogenous bonds for basic refractories. Bulletin 70 may be had without charge on application to the director of the Station.

THE DEATH OCCURRED at Camborne on Saturday, December 17, after a short illness, at the age of 41, of Mr. Thomas John Uren, who was engaged on the staff of Messrs. Holman Bros., Limited, Engineers and Ironfounders, as a chemist. Mr. Uren, who was trained at the Camborne School of Mines, was a former chairman of the Camborne Urban District Council, upon which he had served for six years.

XUM

This Week's News in Brief.

Trade Talk.

MESSRS. H. W. LINDOP & SON, Junction Foundry, Pleck Road, Walsall, have placed an order with Pitteville & Company for a Sesci furnace of 5 tons capacity.

IN ORDER to speed up the output, Messrs. Colville, Limited, Dalzell Steel Works, Motherwell, are converting one of the steam-driven mills to electric drive. It is proposed to convert the other mills to electric driving in the near future.

THE REFRACTORIES ASSOCIATION OF GREAT BRITAIN are holding their ninth Annual Ball at the Royal Victoria Hotel, Sheffield, at 7 p.m. on January 6, 1933. Applications for tickets should be made to Mr. Alex. Lomas, Messrs. J. & J. Dyson, Limited, Stannington, near Sheffield.

THE ANNUAL MEETING of the Sheffield Society of Engineers and Metallurgists was held on Monday, December 12. Prof. F. C. Lea was elected President. After the meeting a discussion was held jointly with members of the Refractories Association of Great Britain on "Steel Works Demands in Refractories." It was opened with two short Papers by Messrs. R. J. Sarjant and W. J. Ross.

CONTRIBUTIONS TO INFIRMARIES and other charitable institutions for the current year have been made by the employees of the following firms:—Colvilles, Limited, Dalzell Steel & Iron Works, £4,374 7s. 2d.; Etna Iron & Steel Company, Limited, Motherwell, £103; North British Manufacturing Company, Limited, Glasgow, £55; and the Springfield Steel Company, Limited, Glasgow, £45.

TWO LARGE POWERED reduction-gear units for operating oil-field pumps have been shipped to Burmah by Messrs. Beckett & Anderson, Limited, of Glasgow. Each unit is driven by two electric motors and is capable of transmitting 875 b.h.p. The gearing is totally enclosed and lubricated by a special pump housed within the steel gear case. This is the third order for similar gears for the same destination.

IT IS ANNOUNCED that, in order to further the economy in design, the propelling machinery of the two ships ordered from Messrs. Lithgows, Limited, Port Glasgow, by Messrs. J. & C. Harrison, Limited, will incorporate the Gotaverken turbo-compressor system of steam-engine economy. The British licensees of the Gotaverken system are Messrs. David Rowan & Company, Limited, Glasgow, who are supplying the engines for the new vessels.

AS A RESULT of the recent incessant rainfall, a slight explosion took place in the Torwood Foundry, Larbert, of Messrs. Jones & Campbell, Limited. The mishap took place whilst a bogie of metal was being wheeled from the cupola to the moulds; part of the track, which had become flooded, gave way, causing the bogie to cant and some of the metal fell into the water. Several of the men received burns about the legs and chest, although none was seriously injured.

THE DUTCH GOVERNMENT have decided to adopt the latest type of Yarrow high-pressure water-tube boiler in a new cruiser being built by Messrs. Wilton-Fojenoord, of Rotterdam, and Messrs. Yarrow have received an order to supply complete working drawings of these boilers. The boilers of the new cruiser will be similar to those fitted on eight torpedo-boat destroyers built a few years ago for the Dutch Navy under the technical supervision of Messrs. Yarrow.

SEVEN MEN LOST their lives and two others were seriously injured in an explosion in Cortonwood Colliery, Wombwell, recently. The explosion occurred in the Silkstone seam shortly before midnight, about 20 men being at work in the seam at the time. It is believed that gas may have come out of some old waste. Rescue parties were sent for, but were not required to go down the pit. The owners of the pit, which was first sunk in 1873, are the Cortonwood Collieries, Limited. This is the first serious accident at the colliery.

MESSRS. LITHGOWS, LIMITED, Port Glasgow, have launched the "Hardingham," the fifth this year for Messrs. J. & C. Harrison, Limited, London. The vessel is of the single-deck type with poop, long bridge and forecastle, and has been built to Lloyd's highest class. She is 440 ft. overall length and 56½ ft. in breadth, with a deadweight capacity of 9,000 tons on moderate draft. The propelling machinery supplied by Messrs. David Rowan & Company, Limited, Glasgow, will consist of triple-expansion engines with cylinders 25 in., 43 in. and 72 in. by 48-in. stroke, with three boilers, two of which are fitted with superheaters and working at 220 lbs. per sq. in. pressure.

LANARKSHIRE COUNTY COUNCIL Highways Department have undertaken an experiment with the cast-iron road plates which have been patented by Shotts Iron Company, and have laid part of the Stirling-Carlisle road near Newhouse with them. The plates are of cast iron 1 ft. square, ribbed, perforated and interlocking. No concrete foundation is required—only a layer of ashes and tar macadam on top. It is claimed by the Shotts Company that the use of the plates will give long life and a level surface. Many county and burgh surveyors have visited the road to see the laying of the plates. The moulders in Shotts' foundry are watching the results with no small interest and in anticipation of continuous employment in the event of success.

ACCOMPANYING THE REPORT of Sheffield Steel Products, Limited, are details of a scheme formulated by the directors, in consultation with nine of the largest debenture stockholders, for meeting the situation which may arise should the present exceptional trading conditions continue. Although the company has a large surplus of liquid assets over current liabilities it might become inadvisable to deplete the liquid resources by the continued payment of debenture interest, and it is therefore proposed that interest for the three years ending November 21, 1935, shall only be paid if a committee of four debenture stockholders, which is to be formed, considers this can be done without detriment to the carrying on of the business. No distribution is to be made on the ordinary stock until all debenture interest has been paid in full and all deferred interest is to become payable in any event on November 21, 1935. In future whenever a dividend is declared on the ordinary stock a sum equal to 25 per cent. of the gross amount of the dividend is to be applied to the redemption of debenture stock. It is further proposed that debenture stockholders shall be given an option until November 21, 1942, to subscribe at par for 10 ordinary 1s. shares in respect of every £1 of debenture stock now held.

Company Reports.

Yarrow & Company, Limited.—Net profit, £18,479; brought in, £18,382; dividend of 5 per cent.; to general reserve, £10,000; carried forward, £19,361.

Stewarts & Lloyds of South Africa, Limited.—Profit, £54,465; brought in, £2,625; depreciation, etc., £20,172; first preference dividend, £18,000; second preference dividend, £17,500; carried forward, £1,418.

Cleveland Bridge & Engineering Company, Limited.—Net profit, £18,149; brought in, £8,247; final ordinary dividend of 3½ per cent., making 5 per cent., tax free, for the year; to reserve, £2,000; carried forward, £7,933.

Duffield Iron Corporation, Limited.—The report for the year ended September 30 states that since the last annual meeting consistent and effective progress has been made. Until the latter part of last month no definite stage had been reached to warrant the issue of a progress report. Trials have now resulted in the making of a product superior to ordinary pig-iron. Its analysis approximates to that of steel. Development expenditure during year amounted to £11,476, increasing the total of that item to £28,914.

Two-Ply Stainless Steels.—The method of producing stainless-clad steel developed recently by the Ingersoll Steel & Disk Company, Chicago, was described recently at a meeting of the Chicago section of the American Welding Society by W. W. PATTRICK, chief metallurgist of the company. According to Mr. Patrick, the fact that the two-ply metal can be produced at approximately one-half the cost of solid stainless steels opens up its use to many applications where beauty, permanence and corrosion resistance are desired, but where the cost of solid stainless is prohibitive.—"Steel."

Obituary.

MR. JAMES HARRISON BARRANS, iron merchant, of Bradford, has died at the age of 64.

MR. DAVID LEWIS, senior partner and founder of Messrs. Lewis & David, Limited, engineers and founders, Aberavon, has died in his 82nd year.

MR. A. K. REESE, a former general manager of the Dowlais Iron and Steel Works, Cardiff, has died in Johannesburg, South Africa. Mr. Reese joined Messrs. Guest, Keen & Company in 1902. He went out to South Africa some years ago to superintend the construction of blast furnaces, first on behalf of his company and later for the Government. He was a native of Baltimore, U.S.A.

THE DEATH has occurred in a London nursing home of Mr. John Cochran Boyd, assistant works manager to Messrs. Thomas White & Sons, Limited, engineers and ironfounders, Laighpark, Paisley. Mr. Boyd, who was 44 years of age, went to London a week or two ago to supervise the erection of plant in an industrial establishment, but became suddenly unwell, and had to undergo an operation. Mr. Boyd served his apprenticeship with Messrs. Fleming & Ferguson, Limited, Paisley.

SIR FREDERICK LOBNITZ, chairman of Messrs. Lobnitz & Company, Limited, engineers and shipbuilders, of Renfrew, died at his home at Crookston, Renfrewshire, on December 7, in his 70th year. He was the patentee of many inventions for improvements in dredging machinery, especially for the excavation of rock under water without explosives. Early in the war he rendered valuable service in promoting the manufacture of munitions by workers without previous experience, and was made Deputy Director of Munitions in Scotland in 1915 and Director in 1917. In 1919 he received the Legion of Honour, and in 1920 he was created K.B.E. He was a member of the Institution of Civil Engineers.

Personal.

SIR LESLIE SCOTT, K.C., has accepted the post of independent chairman of the committee which the copper producers and consumers have set up to advise the Government on questions arising from the Ottawa Agreements relating to copper.

MR. ARNOLD H. A. BRAUER has been appointed supervisor of the London office and of the activities of the Leipzig Fair in Great Britain. This follows the appointment of Mr. Edgar H. P. Meyer to the management of the Leipzig Fair interests in South-Eastern Europe. The change will take effect as from January 1, 1933.

Contracts Open.

Cairo, January 9.—Two pumping units comprising centrifugal pumps, motors, piping, etc., for the Ministry of Public Works. The Department of Overseas Trade. (Reference G.X. 12,089.)

Cairo, May 10.—Supply of materials for and erection of Aswan hydro-electric station, for the Ministry of Public Works. The Inspecting Engineer, Egyptian Government, 41, Tothill Street, London. (Fee £E.50, non-returnable.)

Mablethorpe, January 3.—Two sets of well pumps and oil engines, for the Mablethorpe and Sutton Urban District Council. Messrs. Silcock & Simpson, 25, Victoria Street, Westminster, S.W.1. (Fee £5 5s., returnable.)

New Company.

Ealing Park Foundry, Limited.—Capital £5,000. Directors: H. Shannon and R. B. Templeton.

Import Duties.

The Import Duties Advisory Committee give notice of applications for drawback under Section 9 of the Finance Act, 1932, in the case of oil and water coolers for marine turbine engines in respect of the cupro-nickel tubes used in their manufacture; or, alternatively, under Schedule II of the Import Duties Act, in respect of cupro-nickel tubes for oil and water coolers.

The Committee also give notice of applications for an increased duty on iron and steel hinges and for the addition to the free list of silico-manganese.

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Silicon	2% to 5%	1% to 3%
Sulphur	·01% to ·04%	·04%
Phosphorus	1·6%	·5% to ·8%
Manganese	·35%	·5% to ·1%

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Raw Material Markets.

Business with consumers has been very quiet in all markets and there will be little activity until the beginning of the New Year. Prices have been firm in nearly all sections of the iron and steel markets and trading in January will start upon a much firmer basis than was the case a year ago.

In the base-metal markets the chief feature has been the decline in copper, following the failure of the producers to come to any agreement for the New Year.

Pig-Iron.

MIDDLESBROUGH.—New business in Cleveland iron has practically ceased, and there has also been the usual pause in deliveries to consumers, consequent upon the customary period of stock-taking. It is generally felt that the trade is now in a stronger position. Local consumers have been showing slightly more activity, whilst Continental iron has been excluded from the market. Despatches to the Continent have shown a small increase, following slight reductions in their export quotations made by the Cleveland makers. Prices are still firm, No. 1 Cleveland foundry quality being at 61s. per ton, No. 3 Cleveland G.M.B. at 58s. 6d., No. 4 foundry at 57s. 6d., and No. 4 forge iron at 57s. per ton.

There is no change to report in the East Coast hematite market. It is thought, however, that some increase in price may shortly be made, as there has been a rise both in ore freights and in coke prices. Prices, which have been at a low level for some time remain at 59s. per ton for mixed numbers, with 6d. extra for No. 1 quality. In the West Coast hematite market the position remains steady; Bessemer mixed numbers are at 66s. per ton.

LANCASHIRE.—One or two forward orders for delivery over the early part of next year have come to hand, but, generally speaking, there is little business moving. Good machinery scrap continues to be sold locally at very low prices, at a shilling or two below 30s. per ton, delivered. Pig-iron quotations show very little alteration. Midland brands of No. 3—Staffordshire and Derbyshire—are on offer on the basis of 67s. per ton delivered in the Manchester price zone, with Cleveland also at about this price, Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish No. 3 at around 82s. 6d., and East and West Coast hematite iron at about 76s. and 81s. per ton, respectively.

MIDLANDS.—Requisitions from the foundries have fallen away during the last few days, and the works will shortly be ceasing activities in most cases for a week. Prospects for the New Year are fairly good, although the demand from the heavy engineering foundries fails to improve. Prices are unaltered, the minimum figures obtaining in Birmingham and the Black Country being 62s. 6d. for Northants No. 3 and 66s. for South Staffordshire, Derbyshire and Lincolnshire No. 3. A little Cleveland No. 3 foundry iron is coming into the South Staffordshire district at the same price as Derbyshire No. 3, but foreign iron remains uncompetitive.

SCOTLAND.—Business has already tapered off in view of the approaching holidays. Prices are unchanged, Scottish No. 3 foundry being at 67s. 6d. per ton, f.o.t. furnaces, with 2s. 6d. extra for No. 1. Middlesbrough iron remains at 54s. f.o.t. Falkirk, Northants iron being a shilling less.

Coke.

Apart from the purchasing of one or two small lots for immediate consumption, there has been very little activity in this market, and interest is gradually slackening off. Best Durham cupola coke is at 36s. 6d. to 38s. per ton delivered Birmingham, with Welsh quotations varying from 30s. to 45s., according to analysis.

Steel.

The home demand has fallen away, as is usual at this time of year. In the finished-steel department export inquiries have increased, but the proportion of business following has not been very great. Continental material has still a footing in this country. Semi-finished material is in little demand at the moment, but the British works are fairly well situated with regard to orders, Continental material being uncompetitive.

Scrap.

Sales of iron and steel scrap have slackened down considerably, but sellers are by no means anxious to do business at the present level of prices. They claim that, in view of the improved demand, and the fact that large quantities of scrap are being shipped out of the country, there is a strong probability of increased prices in the New Year. Several price increases have been noted this week, the South Wales quotation for heavy cast iron strengthening to 42s. 6d., while in Scotland cast iron has increased to 39s. 6d. and heavy machinery to 44s. 6d.

Metals.

Copper.—Many rumours continue to circulate as to the possibility of a last-minute output-control agreement between producers. The market has, in consequence, fluctuated considerably. It is said that the American mines are to restrict their output to 20 per cent. of capacity, as before, but they have, of course, an exclusive domestic market to distribute amongst themselves. Whether the Rhodesian and Canadian producers will come to any such agreement will probably not be seen until Great Britain finally decides to impose the duty upon foreign copper which was promised at the Ottawa conference. Business with consumers has shown a seasonal decline.

Closing quotations :—

Cash.—Thursday, £27 15s. to £27 17s. 6d.; Friday, £28 to £28 2s. 6d.; Monday, £29 1s. 3d. to £29 2s. 6d.; Tuesday, £28 13s. 9d. to £28 16s. 3d.

Three Months.—Thursday, £28 2s. 6d. to £28 3s. 9d.; Friday, £28 7s. 6d. to £28 8s. 9d.; Monday, £29 8s. 9d. to £29 10s.; Tuesday, £29 to £29 2s. 6d.

Tin.—The consumption of tin remains limited, the one busy user being the South Wales tinplate industry. Other consumers are very hesitant and there has been little forward buying for the coming year. The effect of the recent rigid curtailment of output has been largely nullified by the slackness in the consuming industries.

Official closing prices :—

Cash.—Thursday, £149 2s. 6d. to £149 5s.; Friday, £149 12s. 6d. to £149 15s.; Monday, £149 7s. 6d. to £149 12s. 6d.; Tuesday, £149 to £149 5s.

Three Months.—Thursday, £150 7s. 6d. to £150 10s.; Friday, £150 15s. to £151; Monday, £150 15s. to £150 17s. 6d.; Tuesday, £150 10s. to £150 12s. 6d.

Spelter.—Trade interest in this metal has fallen off, but the position remains fundamentally sound, and producers report that unsold stocks have been progressively reduced during the winter months.

Daily fluctuations :—

Ordinary. — Thursday, £15 7s. 6d.; Friday, £15 7s. 6d.; Monday, £15 11s. 3d.; Tuesday, £15 8s. 9d.

Lead.—The market has been very sluggish recently, but it is hoped that a buying movement will be witnessed during January. Recent arrivals in Great Britain have been heavier than usual, and good supplies are on hand.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11; Friday, £11 2s. 6d.; Monday, £11 7s. 6d.; Tuesday, £11 3s. 9d.

Pig-iron Combine in Japan.—According to a report from Yokohama, the Commercial and Industrial Minister of Japan recently asked the Director of the Imperial Works at Yawata to get and submit to him figures of the output of pig-iron and its cost of production at each of the various blast-furnace plants in Japan. Proposals have been made to amalgamate the six pig-iron producers, but a difference in their interests is thought to make that very hard of realisation. According to an official investigation, the cost of production in Japan is 53 yen (£3 10s. 8d.) for steel ingots, and 40 yen (£2 13s. 4d.) for pig-iron per ton. The Minister is afraid that by buying up the iron and steel works such an enormous amount of capital would be locked up as to make the business unprofitable, and cause too for a rise in the prices in consequence, that would only aggravate the situation. He seems to be, however, inclined to have the leading pig-iron works bought up by the Yawata works, if possible, but at the moment to be doubtful about finding the necessary funds.

Students' Corner.

Q.—What is the relationship of diameter of cupola shaft to the melting capacity per hour?

A.—The area, or diameter, of the bore of the cupola at or near the melting zone decides how many tons of iron will be melted per hour, the following approximate figures are borne out in practice.

Dia. of Cupola in inches.	Quantities per hour melted. Tons	cwts.
20	1	0
24	1	10
30	3	0
36	4	5
43	6	1
48	7	10
54	9	1
60	11	15
62	12	11
66	14	15
72	18	0

Some cupolas may not quite reach these figures, whilst others may exceed them.

Q.—What distance should the tuyeres be placed from the bottom of the cupola?

A.—About 18 in. It must be remembered that if the tuyeres be situated high, or low, from the bottom of the cupola, that the coke underneath the tuyeres does not assist in melting the iron. Hence the nearer the bottom the tuyeres are placed (within reason), the greater will be the saving of coke.

Q.—What should be the position of the slagging hole?

A.—Not less than 4 in. below the bottom of the tuyere, this is obvious because if the slagging was located higher there would always be a danger of the molten metal running into the tuyeres, also the slagging hole should normally be kept open; this will indicate to the melter when to tap out.

Q.—When charging the cupola for a "blow" what should be the depth of the bed charge of coke?

A.—This should be measured from the top of the tuyeres and not from the bottom of the cupola. Roughly the depth of coke from the top of the tuyere should be 24 in. But the exact depth should be ascertained by experiment with each cupola. The depth of the bed coke may be varied for a week, both increasing and decreasing in amount. A good guide for the correct depth will be, providing the fire is well burnt through when the cupola is charged, if molten metal commences to trickle down after the blast has been on 10 minutes, the gauge for the bed charge of coke is not far wrong.

After this has been determined, for economical reasons, and uniform working, a gauge indicating this depth from the charging door should be used, and strictly adhered to.

(To be continued.)

XUM

GREAT ECONOMY!

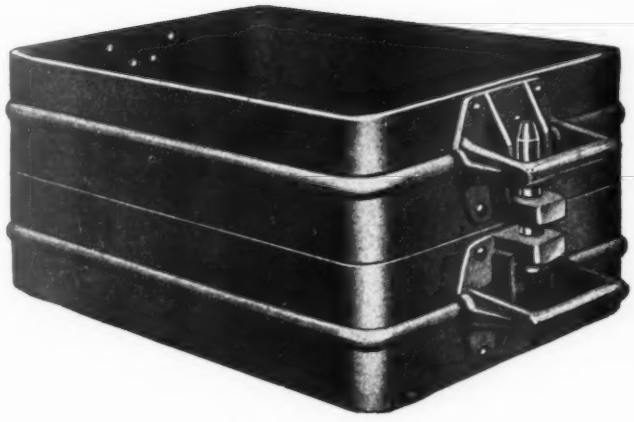
ONE of the greatest improvements you can introduce into your foundry is the STERLING ROLLED STEEL MOULDING BOX.

The result will be economy all round.

Your moulders will put down more moulds per day because STERLING BOXES are light and easy to handle;

You will be sure of an accurate product because STERLING BOXES are accurately made and maintain this accuracy permanently;

Your box maintenance costs will be at least halved because however heavy the service STERLINGS cannot crack or break.



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Manchester: F. L. HUNT & CO., CHAPEL STREET, SALFORD, MANCHESTER.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	28	13	9
Three months	29	0	0
Electrolytic	33	10	0
Tough	30	15	0
Best selected	31	5	0
Sheets	61	0	0
India	41	10	0
Wire bars	34	0	0
Do., Jan.	34	5	0
Do., Feb.	34	10	0
Ingot bars	34	0	0
H.C. wire rods	36	15	0
Off. av. cash, November	32	0	4 1/16
Do., 3 mths., November	32	5	0 15/16
Do., Sttlmnt., November	32	0	5 1/16
Do., Electro, November	36	17	10 1/16
Do., B.S., November	34	19	8 3/4
Do., wire bars, November	37	4	1 1/16
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10½d.
Rods, drawn	7½d.
Rods, extd. or rlld.	4¾d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7d.
Yellow metal rods	4¼d.
Do. 4 × 4 Squares	5¼d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	149	0	0
Three months	150	10	0
English	149	10	0
Bars	153	5	0
Straits	154	12	6
Australian	152	17	6
Eastern	154	2	6
Banca	155	7	6
Off. av. cash, November	153	13	3 6/11
Do., 3 mths., November	154	11	7 17/22
Do., Sttlmt., November	153	13	4 10/11

SPELTER.

	£	s.	d.
Ordinary	15	8	9
Remelted	15	5	0
Hard	13	5	0
Electro 99.9	17	15	0
English	16	12	6
India	14	15	0
Zinc dust	22	0	0
Zinc ashes	2	15	0
Off. aver., November	15	7	11 24/44
Aver. spot, November	15	5	3 9/22

LEAD.

	£	s.	d.
Soft foreign ppt.	11	3	9
Empire	11	12	6
English	12	15	0
Off. average, November	12	4	7 10/11
Average spot, November	12	1	5 5/22

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whse.	24	5	0
Rods	27	0	0
Boiler plates	23	0	0
Battery plates		—	

ANTIMONY.

	£	s.	d.		£	s.	d.
English	37	10	0	to	42	10	0
Chinese					27	0	0
Crude					19	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro silicon—			
25%	8	0	0
45/50%	13	15	0
75%	19	10	0
Ferro-vanadium—			
35/50%	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	6/3 per lb. of Mo.		
Ferro-titanium—			
23/25% carbon-free	10d. lb.		
Ferro-phosphorus, 20/25%	£18	7	6
Ferro-tungsten—			
80/85%	1/7½ lb.		
Tungsten metal powder—			
98/99%	1/10½ lb.		
Ferro-chrome—			
2/4% car.	£32	10	0
4/6% car.	£25	0	0
6/8% car.	£24	17	6
8/10% car.	£23	10	0
Ferro-chrome—			
Max. 2% car.	£36	0	0
Max. 1% car.	£40	2	6
Max. 0.70% car.	£43	12	6
70% carbon-free	1/- lb.		
Nickel—99.5/100%	£250 to £255		
"F" nickel shot	£225	0	0
Ferro-cobalt	7/3 lb.		
Aluminium 98/99%	£100	0	0
Metallic chromium—			
96/98%	2/9 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to £11 5 0		
76/80% packed	£11 15 0 to £12 5 0		
76/80% export	(nom.) £9 15 0		
Metallic manganese—			
94/96% carbon-free	1/4 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Heavy steel					2	0	0
Bundled steel and shrngs.	1	15	0	to	1	19	0
Mixed iron and steel	1	14	0	to	1	17	6
Heavy cast iron					2	2	6
Good machinery	2	5	0	to	2	7	6
Cleveland—							
Heavy steel	1	17	6	to	2	0	0
Steel turnings					1	11	6
Cast-iron borings					1	3	6
Heavy forge					2	10	0
W.I. piling scrap					2	2	6
Cast-iron scrap	1	17	6	to	2	0	0
Midlands—							
Light cast-iron scrap					1	16	0
Heavy wrought iron					2	2	6
Steel turnings, f.o.r.					1	0	6
Scotland—							
Heavy steel					1	15	0
Ordinary cast iron					1	19	6
Engineers' turnings					1	9	6
Cast-iron borings					1	10	0
Wrought-iron piling					1	19	0
Heavy machinery					2	4	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	21	0	0
Brass	14	0	0
Lead (less usual draft)	10	0	0
Tea lead	8	10	0
Zinc	8	10	0
New aluminium cuttings	72	0	0
Braziery copper	19	0	0
Gunmetal	18	0	0
Hollow pewter	80	0	0
Shaped black pewter	60	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
„ at Falkirk	54/-
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	59/6
Hematite M/Nos.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/-
„ d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	61/-
„ No. 3 fdry.	66/-
Northants forge	57/6
„ fdry. No. 3	62/6
„ fdry. No. 1	65/6
Derbyshire forge	61/-
„ fdry. No. 3	66/-
„ fdry. No. 1	69/-
„ basic	—
Scotland—	
Foundry No. 1	70/-
„ No. 3	67/6
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	0	0	to	9	15	0
Nut and bolt iron	7	15	0	to	8	0	0
Hoops	10	10	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					13	0	0
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	8	7	6	to	9	5	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)	6	15	0	& up.			
Flats—8 in. wide and over					8	12	6
„ under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	10	0	to	10	10	0
Black sheets, 24g. (10-t. lots)					9	5	0
Galv. cor. shts. „					11	5	0
Galv. flat shts. „					11	15	0
Galv. fencing wire, 8g. plain					14	0	0
Billets, soft	4	17	6	to	5	7	6
Billets, hard	6	12	6	to	7	2	6
Sheet bars	4	15	0	to	5	2	6
Tin bars					4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10¾d.
Sheet to 10 w.g.	11¼d.
Wire	11¾d.
Rods	10¾d.
Tubes	16d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 25/-
„ furnace	16/- to 16/6
Durham and Northumberland—	
„ foundry	21/- to 25/-
„ furnace	13/3 to 13/9
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		16/-
„	28×20 „		32/-
„	20×10 „		23/-
„	18¾×14 „		16/7½
C.W.	20×14 „	13/9 to	14/6
„	28×20 „	29/3 to	29/6
„	20×10 „		19/10
„	18¾×14 „		14/-

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	10	0	to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	5	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
Dec.	15 ..	27 15 0	No change
,,	16 ..	28 0 0	inc. 5/–
,,	19 ..	29 1 3	,, 21/3
,,	20 ..	28 13 9	dec. 7/6

Standard Tin (cash).

		£ s. d.	
Dec.	15 ..	149 2 6	inc. 17/6
,,	16 ..	149 12 6	,, 10/–
,,	19 ..	149 7 6	dec. 5/–
,,	20 ..	149 0 0	,, 7/6

Spelter (ordinary).

		£ s. d.	
Dec.	15 ..	15 7 6	inc. 6/3
,,	16 ..	15 7 6	No change
,,	19 ..	15 11 3	inc. 3/9
,,	20 ..	15 8 9	dec. 2/6

Zinc Sheets (English).

		£ s. d.	
Dec.	15 ..	24 10 0	No change
,,	16 ..	24 10 0	,, ,,
,,	19 ..	24 10 0	,, ,,
,,	20 ..	24 10 0	,, ,,

Electrolytic Copper.

		£ s. d.	
Dec.	15 ..	33 0 0	No change
,,	16 ..	32 15 0	dec. 5/–
,,	19 ..	34 5 0	inc. 30/–
,,	20 ..	33 10 0	dec. 15/–

Tin (English ingots).

		£ s. d.	
Dec.	15 ..	149 15 0	inc. 15/–
,,	16 ..	150 5 0	,, 10/–
,,	19 ..	150 0 0	dec. 5/–
,,	20 ..	149 10 0	,, 10/–

Spelter (Electro, 99.9 per cent.).

		£ s. d.	
Dec.	15 ..	17 10 0	inc. 5/–
,,	16 ..	17 10 0	No change
,,	19 ..	17 15 0	inc. 5/–
,,	20 ..	17 15 0	No change

Lead (English).

		£ s. d.	
Dec.	15 ..	12 10 0	No change
,,	16 ..	12 10 0	,, ,,
,,	19 ..	12 15 0	inc. 5/–
,,	20 ..	12 15 0	No change

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	0 17 6	0 14 0	0 13 0	0 14 0	0 14 6	0 15 0	0 15 3	0 15 3	0 15 9	0 16 6	0 16 9	0 16 9	0 16 4½
1902	0 16 9	0 15 0	0 15 0	0 15 0	0 15 0	0 15 3	0 15 3	0 15 3	0 15 6	0 16 0	0 16 6	0 16 0	0 15 5
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 8½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½ (5 months)
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	Strike	Strike	Strike	Strike	Strike	Strike	Strike	1 5 0	1 1 1½
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 6	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	0 15 0	0 16 9	0 17 0	0 16 6	0 16 0½
1932	0 17 0	0 16 11½	0 16 5½	0 15 9	0 15 7½	0 15 6	0 15 6	0 14 9½	0 14 6½	0 14 6	0 14 6	—	—

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